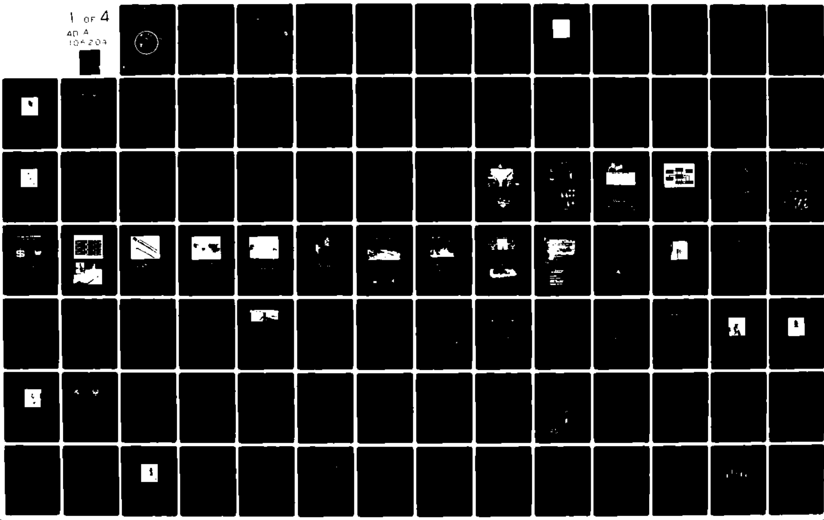
AD-A105 209 DEPARTMENT OF DEFENSE WASHINGTON DC F/G 13/8
PROCEEDINGS OF THE ANNUAL TRI-SERVICE MANUFACTURING TECHNOLOGY --ETC(U)
OCT 80

UNCLASSIFIED NL

1 OF 4
AD A
105209



PROCEEDINGS OF THE TWELFTH ANNUAL TRI-SERVICE MANUFACTURING TECHNOLOGY CONFERENCE

MTAG '80

SHERATON-BAL HARBOUR
BAL HARBOUR, FLORIDA

19-23 October 1980

THEME

The Department of Defense has long recognized the need to develop and exploit new or improved manufacturing technology. The objectives of this Conference were to bring together the leaders of manufacturing technology from the government, industry and academia to exchange information and to review future DoD plans and past accomplishments to assure a coordinated, effective effort directed toward improving DoD materiel acquisition.

PROCEEDINGS OF THE
[redacted] ANNUAL
TRI-SERVICE MANUFACTURING TECHNOLOGY
CONFERENCE

19-23 October 1980

SHERATON-BAL HARBOUR

BAL HARBOUR, FLORIDA

GENERAL PROGRAM

SUNDAY, 19 OCTOBER 1980

ADVANCED REGISTRATION — 2:00-7:00 p.m.
Main Lobby

EARLY BIRD RECEPTION — 7:00-8:30 p.m.

MONDAY, 20 OCTOBER 1980

REGISTRATION, Main Lobby — 7:00 a.m.

OPENING SESSION — 8:00-12:00 noon
Grand Ballroom

ADMINISTRATIVE REMARKS - *Mr. Raymond L. Farrow*

WELCOME - *Mr. Darold L. Griffin*

KEYNOTE ADDRESS - *General John R. Guthrie*, Commanding General, U. S. Army Materiel Development and Readiness Command

OVERVIEW OF MANUFACTURING
TECHNOLOGY PROGRAMS

U.S. ARMY - *Mr. Darold L. Griffin*, Chief, Office of Manufacturing Technology, U.S. Army Materiel Development and Readiness Command

U.S. NAVY - *CPT Fred Hollick*, Director, Manufacturing Technology Program, Naval Material Command

U.S. AIR FORCE - *Mr. James J. Mattice*, Director of Manufacturing Technology, Air Force Wright Aeronautical Laboratories

DARPA - *Dr. Michael J. Buckley*, Program Manager, Materials Science Division

DEPT. OF COMMERCE - *Mr. Charles H. Kimzey*, Office of Cooperative Generic Technology

TECHNICAL SUBCOMMITTEE OVERVIEWS, Grand Ballroom — 1:30-5:00 p.m.

CAD/CAM - *Mr. Fred Michel*

Electronics - *Mr. Charles McBurney*

Inspection and Test - *Mr. Edward Criscuolo*

Metals - *Mr. Gordon Ney*

Munitions - *Mr. Robert Mesuk*

Non-Metals - *Mr. Robert Tomashot*

INFORMATION TRANSFER — 8:00-10:00 p.m.
Floridian Room

Moderator - *Dr. Lloyd Lehn*, Assistant for Manufacturing Technology, Office of the Under Secretary of Defense for Research and Engineering

Center for Utilization of Federal Technology - *Ms. Marjorie King*, Department of Commerce

Information Services Available from DTIC - *Mr. Paul Klinefelter*, Defense Technical Information Center

Army Manufacturing Technology Data Base System - *Mr. John Petrone*, U.S. Army Industrial Base Engineering Activity

Need for Manufacturing Technology Information Analysis Center - *Mr. Louis Gonzalez*, General Electric - Tempo.

NASA - *Mr. Floyd I. Roberson*, Director, Technology Transfer Division

TUESDAY, 21 OCTOBER 1980

INDUSTRIAL SOCIETY PRESENTATIONS, Grand Ballroom — 8:30-12:00 noon

American Defense Preparedness Association - *Mr. Robert Hilchey*

Aerospace Industries Association - *Mr. Ralph Patsfall*

American Welding Society - *Mr. Robert C. Holland* and *Mr. Ronald C. Reeve*

Electronic Industries Association - *Mr. Dale Hartman*

Numerical Control Society - *Mr. Edward Toton*

INDUSTRIAL SOCIETY PRESENTATIONS, Grand Ballroom — 1:30-2:30 p.m.

National Machine Tool Builders Association - *Mr. John Deam*

Society of Manufacturing Engineers - *Dr. John Kahles*

NBC WHITE PAPER — 3:00-4:30 p.m.
IF JAPAN CAN, WHY CAN'T WE
Floridian Room

EXHIBITS (Open) — 2:30-5:30 p.m.
Grand Ballroom

EXECUTIVE FORUM — 3:00-5:00 p.m.
Caribbean Suite (By Invitation Only)

Moderator - *Mr. John Blanchard*, Principal Assistant Deputy for Materiel Development, U.S. Army Materiel Development and Readiness Command

RECEPTION (No Host), Poolside	6:30-7:30 p.m.
BANQUET, Grand Ballroom	7:30-10:00 p.m.

BANQUET SPEAKER - *Mr. Peter F. McCloskey*
President, Electronic Industries Association

WEDNESDAY, 22 OCTOBER 1980

INDUSTRY/SUBCOMMITTEE TECHNICAL MINI-SYMPOSIA	8:30-12:00 noon

CAD/CAM - Eastward and Westward #1

Electronics - Pan American Room

Inspection and Test - Barbados Room

Metals - Floridian Room

Munitions - Westward #2

Non-Metals - Bermuda Room

LUNCHEON, Grand Ballroom	12:00-1:30 p.m.

INVITED GUEST SPEAKER
Dr. Arden L. Bement
Deputy Under Secretary of Defense
for Research and Engineering
(Research and Advanced Technology)

INDUSTRY/SUBCOMMITTEE TECHNICAL MINI-SYMPOSIA	1:30-5:00 p.m.

CAD/CAM - Eastward and Westward #1

Electronics - Pan American Room

Inspection and Test - Barbados Room

Metals - Floridian Room

Munitions - Westward #2

Non-Metals - Bermuda Room

TECHNICAL MINI-SYMPOSIA	7:30-9:30 p.m.

Academia Manufacturing Technology - Pan American Room

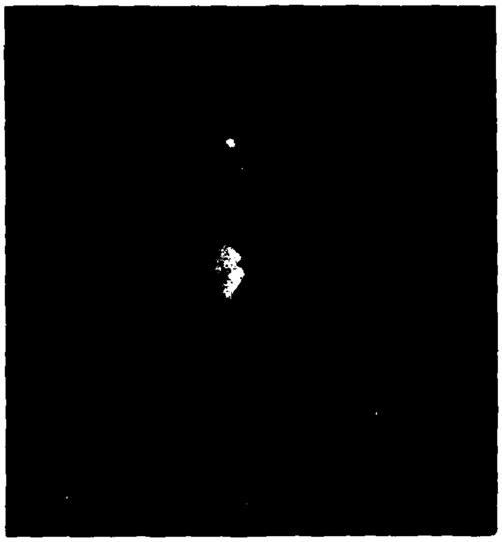
THURSDAY, 23 OCTOBER 1980

EXECUTIVE COMMITTEE Eastward Room	8:30-12:00 noon
TECHNICAL MINI-SYMPOSIA	8:30-12:00 noon

Academia Manufacturing Technology - Pan American Room

Foreign Manufacturing Technology - Floridian Room

CONTENTS



KEYNOTE ADDRESS

by

GENERAL JOHN R. GUTHRIE

Commanding General
U.S. Army Materiel Development and Readiness Command

Thank You John and Good Morning Ladies and Gentlemen.

I'd like to start this morning by seconding John Blanchard's warm welcome to this 12th Tri-Service Manufacturing Technology Advisory Group meeting which the Army is privileged to host.

I would also like to thank the program committee, and all of you, for the opportunity to be here today to participate, in some small way, in your efforts to define the major thrusts of manufacturing technology programs for the next five or more years. My only regret is that prior commitments prevent me from remaining here the full time scheduled for these deliberations, for our theme of "Productivity Growth in the '80's" is of fundamental importance to every member and every segment, military and civilian, domestically or foreign oriented, of our society.

I shall not, in the time permitted me, attempt to delve into the particulars of possible productivity improvements within specific defense or non-defense industries. You who are in, or interact with, industry on a day-to-day basis at management and working levels, know far better than I the problems and their probably remedies. Rather, I would like, from my perspective, to comment on certain directions and initiatives, proposed or already initiated, which relate to industrial productivity and its impact on the military and economic security of our nation. While my emphasis will, obviously, fall on the former, the interdependence of these two areas, and their resultant combined impact on our international political standing, is more acute than ever before in our history -- and can only become more so during the next ten years.

In turn, we -- industry, academia, DOD and the services -- must recognize the intensified imperative for working together which flows from this reality. We have not always felt this imperative, or felt it as strongly, as I believe we now do. And I think it is fundamental to our work here this week that we establish, as our unspoken but ever present objective, that spirit of teamwork which -- if I may build on the theme of this meeting -- is fundamental if we are truly to enhance our productivity.

Without underestimating the difficulties involved, I believe that we must, at all levels, seek to ameliorate or eliminate some of the adversarial elements which, in the past, have crept into our relationships. An it may well be that "productivity," because of its current high visibility throughout every segment of our society, will in fact be the common issue around which we can most easily, and profitably, rally.

In this context -- especially since these meetings are sponsored rotationally by the services -- I am reminded of a remark of my former boss, Secretary of the Army Wilbur Brucker, which, in a backhanded way, stresses the value of a unified effort.

> Every person (he said) who has served with the Navy swells with pride when he hears "Anchors Away," every Marine thrills to the sound of "The Halls of Montezuma," soldiers cheer at the sound of "The Caissons Go Rolling Along" (now the Army song), and Air Force men and women respond to "The Wild Blue Yonder." But did you ever hear anyone shout, or see anyone throw their hats into the air, at "Oh Pentagon, My Pentagon?"

Be that as it may, lastly by way of introduction, let me say that much of what follows may not be new. But, to quote George Orwell, "we have now sunk to a depth at which the re-statment of the obvious is the first duty of intelligent men." It is my belief that, as a defense establishment, as an industrial nation, we must commit ourselves firmly, and quickly, to redressing the military and economic imbalances that we allowed to develop in the 1970's. Moreover, we must, together, move beyond simple commitment: we must apply the requisite talents and resources to achieve and maintain measurable progress.

With all the current talk about reindustrialization and revitalizing the manufacturing sector of our economy, we are extremely vulnerable to equating the start of our journey to the actual achievement of our goal. (I recently saw a bumper sticker that read: Increased Productivity is the answer ... now, what's the question?) True, we must initially ask the right questions, and we must establish goals, building, as we do so, on the vision of our predecessors in these and similar conferences.

But as men and women vitally concerned with the present and future military and economic strength of our nation, we must insure that the structure we seek to devise will not only address the issues of today and tomorrow, but will do so with a realistic and attainable blueprint for solid achievement. We cannot afford to underestimate the magnitude of this challenge, a magnitude well summarized by Mr. Cyrus Vance shortly after he resigned as Secretary of State. He said:

> We must have in our minds a conception of the world we want a decade hence. The 1990 we seek must shape our actions in 1980, or the decisions of 1980 could give us a 1990 we will regret.

In broadcast outlines, the world we seek is one of peace, of human freedom and human dignity. Without doubt, that world will not exist unless we -- the Western World and America in particular -- reach a consensus about the level, rate, and distribution of resources for the near and long term

modernization of both our military forces and our manufacturing sector. And fundamental to achieving this world is our ability to devise and execute measures to rejuvenate the less productive, yet still economically viable, segments of our industrial base -- whether these be directly or indirectly associated with national defense requirements -- and to spur the expansion of those segments which continue to be economic pacesetters in the world market.

How is this to be done? That, in large measure, as I see it, is the task which this meeting is to investigate and on which I hope you will make recommendations.

In subsequent sessions you will hear updates from DOD and Commerce Department representatives on what has been done to date, as well as what is planned for the next year and the succeeding years of this decade. These presentations will focus on the "what"; equally important, we, government and industry, need to discuss candidly the "how" and the "by whom" aspects of our mutual effort. For example, I'm concerned about the escalating costs for defense equipment, costs that are higher than those experienced by the private sector. Why? How does industry keep these latter costs down, and how can we translate this experience to defense work?

In the same vein, 3½ years ago, at a DARCOM-industry meeting, someone asked why we don't use advanced technology to reduce costs of existing systems rather than for increasing performance. After 3½ years, I'm still waiting for a proposal from industry that would do just that.

On the other hand, we in the armed services, and particularly we in the Army, need to simplify and define better our requirements. We should identify better the major thrusts in defense research so that you in academia and in industry can focus your research efforts. We also must continue to recommend strongly, through OSD and OMB to the Congress, changes to the current legal, tax, and depreciation systems that will help create an atmosphere conducive for increased capital investment.

In short, I suggest that our focus be in two areas: identifying precisely the elements and structures of the military, social, and economic structures within which US manufacturing is performed, and the ways in which industry and the military services, separately and together, can influence positively the productivity of American technology in an era dominated not by muscle or natural energy but by human minds and computer electronics -- the era of a new industrial revolution.

What can, what are DOD and the Army in particular doing to help achieve these ends? An initial step, albeit at times an unsteady one, was taken this past summer when the Defense Science Board met to develop specific actions designed to improve the degree of industrial responsiveness to current and possible surge military requirements. While the degradation of responsiveness varies within different industrial sectors, the Board stated that the defense industry in general suffers from major undercapitalization (the result of inflation, money costs, tax policies, competition for limited capital within multi-market firms -- in short, reduced profitability), from critical shortages of engineers and skilled workers, and from growing dependence on foreign sources for critical components such as semiconductors. The DSB also found that increased costs for parts and labor, together with increases resulting from lengthening lead times, are causing weapon system costs to rise at a current annual rate <u>of at least</u> 20%, double the inflation factors used by DOD.

I will not go through each of the recommendations made by DSB. Many are quite familiar to you because of the current -- and growing -- national concern about productivity -- such things as increased depreciation schedules, increased investment tax credits and lower corporate tax rates, and stabilization of production through removal of constraints on the use of multi-year contracts.

Let me, instead, single out two recommendations from the summer study which are pointed directly at the problem of productivity.

First, the DSB recommended that the DOD manufacturing technology program should be given increased emphasis in all the services by funding MANTECH to 1% of each service's procurement budget annually. For FY 80, DARCOM's direct procurement plan totalled \$6117.8 million and our total procurement goal for the fiscal year was \$7538.7. Our original MANTECH program request was \$82 million; that is 1.3% of our direct and 1.09% of our total procurement program, more than the DSB study suggests. While I strongly support the DSB's position for indexing MANTECH to procurement expenditures, I believe that 1% may well be too low. Based on the potential benefits and merits of the project proposals submitted to us and on the opportunities we envision, I would be quite willing to see the funding level rise to some 2%, or possibly higher when special opportunities arise.

Further, whatever base percentage is finally agreed upon, that figure should represent a floor which should not be breached by DOD or any of the services: I said DARCOM's FY 80 MANTECH plan was \$82 million; however, we unilaterally had funds withdrawn from MANTECH in the amount of \$9 million, which left us with an actual investment of .97% of our procurement account.

While there is much verbal support of MANTECH programs, we have a tendency, when the money becomes tight, to draw back from earlier commitments -- to our own, industry's, and, therefore, the nation's, detriment -- because of the results "don't go bang." Yet within the DARCOM program alone, we are currently experiencing a 2.9 to 1 return on those funds actually spent in our manufacturing technology programs.

The second recommendation from the DSB study that I'd like to mention is one which recommends we phase out the "largely obsolete" government-owned machine tool base. Over 75% of all DOD owned metal-working tools are now 20 years old -- or older. A report on industrial preparedness published last year by the Association of the United States Army estimates that by 1982, 70% of the Army's metal-cutting and metal forming tools will have exceeded their useful service life.

I must confess I have mixed feelings about this proposal by the DSB. While the age of these tools cannot be disputed, we have been working steadily both to identify the tools which could be integrated into modern production lines and to rehabilitate them. Senaca Army Depot and, until its conversion to produce the Abrams Tank, our facility at Lima, Ohio have participated in this program for DOD under the direction of the Defense Industrial Plant Equipment Center (DIPEC).

In addition, DIPEC remanufactures machine tools which, with the capabilities added, can be used on short notice in current production, thereby eliminating lead times and producing significant cost avoidances.

For example, in the production of the Army's new Abrams Tank, DIPEC provided 700 tools used by the Lima plant and by subcontractors. These tools, acquired 10 to 20 years ago, originally cost $19.3 million; at today's prices, including inflation, costs for these same tools would have been $61.9 million.

At the Lima facility alone, of 853 tools, 313 -- over 36% -- were provided by DIPEC at a cost of only $6.25 million. The other 540 machines being used cost some $20 million new: that is, less than two-thirds of the machine tools (the new ones) cost more than three times what we expended for the other 36%.

Granted, newer tools might be able to combine some functions being done by one or more of these 700 machines -- and cost us more. But by carefully selecting machines for remanufacturing, we have been able to avoid the costly total recapitalization of our plants.

On the other hand, when no capitalization is done, both costs (especially maintenance) and lead times can be adversely affected. How best to balance funding between remanufactured equipment and totally new capitalization requires a Solomon-like decision, and unfortunately, we do not seem to be too long on Solomons -- and just as short on dollars.

Of course, the reciprocal of the DSB recommendation to phase out government owned tools is that contractors procure, own and maintain them. But in certain areas where there is no commmercial market (as the DSB noted), this is most difficult -- it may even be impossible -- e.g., munitions plants and arsenals and tank production facilities. In these instances, the government has to provide the funds -- and again we must try to make those "wise" decisions that industry has to make when you look at the marketplace.

Besides our infusion of newer technology into the production of the Abrams Tank, DARCOM, with the full support of Congress, is engaged in a massive program to modernize our conventional munitions base. Between FY 70 and FY 80, we spent $2.4 billion in all areas -- facilities, engineering, and manufacturing methods and technology. Of this amount, $949 million (over 39%) was spent on improved mechanical systems alone. These have reduced by 42% our requirements for mobilization manpower in the munitions base, thereby greatly improving our productivity in this vital tri-service sector.

Let me stress, in summarizing this point, that I do not advocate DIPEC as the answer to our national productivity problems. On the other hand, with defense costs as high as they are, and lead times threatening to stretch toward the far horizon, I simply say that we must all do everything possible, in response to these stimuli, to achieve maximum return from those taxpayer dollars which are made available to us.

While recognizing the role of the profit motive for industry, I believe that good stewardship is as much an obligation for those who contract with the government as for those in government. Therefore, we in DARCOM are beginning to focus more of our productivity enhancing efforts on those areas where we interact directly with industry.

Our project managers, in their Production Readiness Reviews (which are performed under the guidance of our MANTECH Office), are stressing the increased use of micro computers and integrated manufacturing systems to improve productivity. Further, a portion of our total MANTECH program is committed to engineering and "return on investment" analyses on which sound decisions can be made by industry to acquire (or defer purchase of) production equipment reflecting the latest available technology.

I don't want to give the impression that initiatives are coming, or should come, only from the services. In fact, two years ago at MTAG '78 in San Diego, representatives of the Electronics Industries Association proposed, as an extension of the Air Force ICAM (Integrated Computer Aided

Manufacturing) program, that DOD explore acquisition and cost-reduction opportunities created by the application of computers and automation to the design and manufacture of electronics equipment. In the past, quite a bit of work had been done in this area, but it had usually been directed toward discrete manufacturing steps rather than an integrated, holistic, "top-down" view combining both existing and expected near term (three to five year) technology.

The result of this recommendation was the creation of the ECAM program -- Electronics Computer Aided Manufacturing. Its objective is to define the architecture of designing and manufacturing electronic equipment and, having so defined the structure and its elements, to identify opportunities for automating selected elements in the manufacturing process that will increase productivity without causing any major disruption in design and manufacturing operations.

The estimated cost of just the definition phase of this tri-service project is $3 million, the bulk of which is to be funded this fiscal year. The final report, to be submitted to the project administrator, DARCOM's Missile Command at Redstone Arsenal, is due in early 1982. What we expect to have detailed in the report is a manufacturing system for DOD electronics which has a common language, improved design flexibility, reduced cycle time, lower product and life cycle costs, and improved quality and reliability.

In summary, I believe that the potential now exists economically, technologically, and psychologically for industry, both defense and non-defense, to begin to regain the productivity superiority our nation once enjoyed in virtually all fields of manufacturing. OSD and the services can help by taking the lead in many areas, foremost of which are program stability, revisions in contracting policy to promote capital investment, and better forecasting of major areas of service interest so that industry and academia can more profitably direct independent research and development efforts.

In turn, industry and academia must continue to be willing to invest talent, time, and treasure to help in revitalizing American manufacturing technology. We cannot afford another decade like the 1970's -- one in which, for example, according to the National Science Foundation, the number of men and women engaged in R&D or technical activity in America rose at an average annual rate of only 2.8% -- from 556,000 to 610,000.

Together, the military services, industry, and academia, must reorient and refocus our vision. We must be willing -- and able -- to look well beyond the day-to-day operating levels and the constraints these tend to impose upon sound, long range managerial and monetary decisions which are at the heart of improving American productivity.

And I would add this final thought, if I may -- again within the context with which I began: cohesion. We cannot afford to make productivity -- or its past decline in America -- a "moral issue" in which various segments of society blame others for what has happened. We must recognize that each of us -- we are all -- to a greater or lesser extent, equally guilty: some for demanding the final 5% capability of systems while incurring unreasonable cost and time delays; others for acceding to that demand and trying to meet it; some for insufficient planning for the realities of changing and/or expanding markets; many for a reluctance to take even small risks, for failing to modernize at a reasonable, planned rate; some for an inability to work harmoniously together to develop and plan a long-range strategy for America -- and all, or at least almost all, of us for not encouraging procedures and products which provide equipment of equal performance and capability to that which we now have but at substantially reduced cost.

Morale, teamwork, integrity ("telling it like it is" and "hearing it like it is") are the imperatives -- the practical economic, military, and psychological imperatives -- through which we can achieve the goal of creating a productivity stimulating and economically profitable environment for all America. We need only be willing, each of us in our own area of expertise, to contribute our ideas and our vision to the cooperative venture of matching people, machines, and the traditional entrepreneurial genius of America to insure the continued economic and military strength of the United States throughout this decade, this century, and beyond.

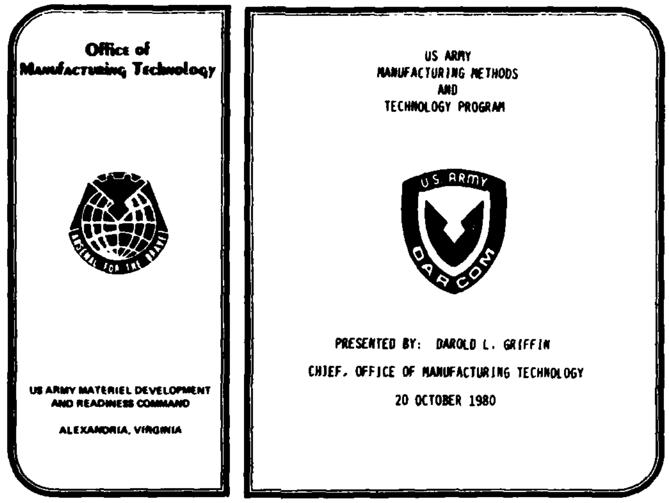
As your Keynoter, my challenge to you who are attending this meeting -- and to those private and governmental interests and agencies you represent -- is to point out the direction and help us to "move out" to seize the opportunity before us -- before it is too late.

ARMY OVERVIEW

by

MR. DAROLD L. GRIFFIN

Chief, Office of Manufacturing Technology
U.S. Army Materiel Development and Readiness Command



Good morning ladies and gentlemen. The purpose of my briefing today is to acquaint you with the Army MANTECH Program, the progress we have made and our future objectives. Our program is now an important source of improvements in productivity, pollution abatement, materials and energy conservation, occupational safety and health and a host of other ideas that determine the cost and availability of modern weapon systems. The most important objective of the program in the 80's is to make a significant contribution to the productivity of our industrial base for weapons production.

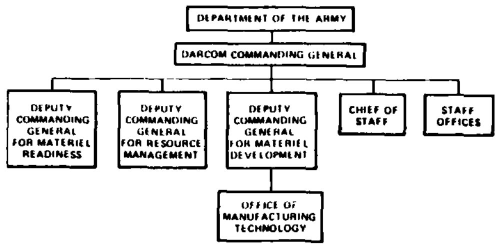
OUTLINE

- PROGRAM OVERVIEW
  - MANAGEMENT
  - OBJECTIVES
  - FUNDING
  - MAJOR THRUSTS FY81
- MANAGEMENT EMPHASIS
- ACCOMPLISHMENTS
- FUTURE GOALS

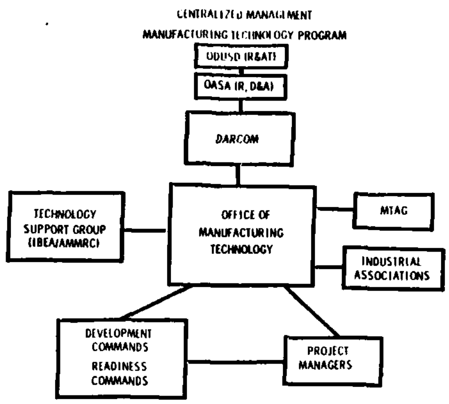
This is an outline of my presentation. The overview will cover the management objectives, funding trends and the major thrusts of the FY 81 Program.

The presentation will also cover areas of management emphasis, examples of past manufacturing technology accomplishments and will conclude with a discussion of our future goals.

ORGANIZATION CHART



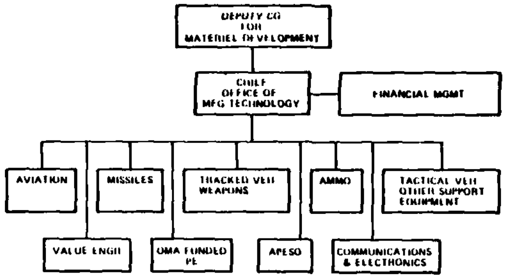
Headquarters DARCOM has been assigned the responsibility for central management of the Army's Manufacturing Technology Program. That responsibility has been fully vested in the Office of Manufacturing Technology as highlighted on this chart. The Chief of the office answers directly to the Deputy Commanding General for materiel development and is only one level away from the Commanding General. This organizational structure streamlines communications and assures high level support and attention to the program.



The management concept of the program is shown here. DARCOM Headquarters through its Office of Manufacturing Technology (OMT) provides centralized management of the program as indicated on the previous chart. Support to the OMT is provided by the Industrial Base Engineering Activity (IBEA) at Rock Island, Illinois, and the Army Materials and Mechanics Research Center (AMMRC) at Watertown, Massachusetts. Interaction with the other services and with private industry is accomplished through the Manufacturing Technology Advisory Group (MTAG) and various industrial associations.

The major subordinate commands and project managers within DARCOM are charged with maintaining manufacturing technology programs. These programs are developed at the field level and screened by senior scientific and professional personnel in a formal review board environment. The boards are assisted by experts from private industry, the academic world and other government agencies as necessary to assure realism in our objectives.

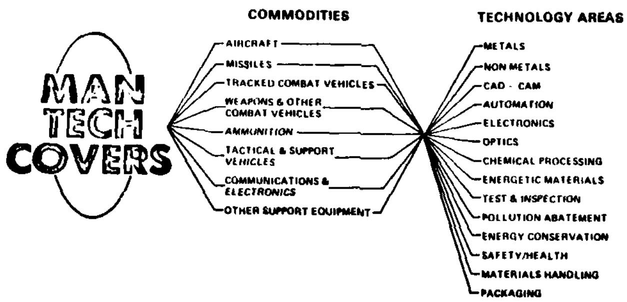
OFFICE OF MANUFACTURING TECHNOLOGY



The Office of Manufacturing Technology is presently comprised of fifteen persons including the chief, a financial management specialist, and professional engineers managing the areas shown on the lower portion of the chart. The office is also responsible for value engineering, design to unit cost, production engineering and the Army Production Engineering Services Office (APESO) all of which are related to and supplement our Manufacturing Technology Program.

While the office is small, its members are highly respected professionals who are often called upon to help solve difficult problems. The office has assisted in a number of assessments of US manufacturing capabilities for high technology systems, and has become the focal point in Headquarters DARCOM for command-wide improvements in productivity.

SCOPE OF DARCOM MANUFACTURING TECHNOLOGY PROGRAM



DARCOM has the broadest Manufacturing Technology Program responsibilities of the three services. This chart shows the major commodities and technologies that are supported within the program. The ammunition program is the largest element of our overall program and supports the Army, Air Force, Navy and Marine Corps. It is truly a DoD technology program and is reviewed and endorsed by the single manager for conventional ammunition.

Our field operations deal in all facets of manufacturing technology as can be seen on the right hand side of the chart. These include all types of metals, nonmetals, computer aided design and manufacture, automation ranging from single machines to major multi-million dollar integrated production facilities, electronics, microelectronics and optics. It also includes chemical processing from simplified unit operations to major chemical manufacturing plants such as those used in the manufacture of propellants and explosives; energetic materials, automated testing and inspection; pollution abatement for metal working, metal processing and chemical manufacturing operations; energy conservation for both personal comfort and unit operations; occupational safety and health and product safety. In addition, it includes materials handling and packaging using a broad variety of materials and techniques.

MT PROJECT EMPHASIS

- PRODUCTIVITY
- SUPPORT OF MAJOR SYSTEMS
- REDUCTION OF LEADTIME
- READINESS

Here in brief is the Army's emphasis: Productivity is the number one issue. It is being accomplished by focusing on advanced technology for major weapon systems, reducing leadtime, and where needed, improving ecology and working conditions. The bottom line of the program is Readiness at a Reasonable Cost.

MT PROGRAM OBJECTIVES

- USE OF ADVANCED MANTECH FOR ECONOMIC PRODUCTION
- BRIDGING THE GAP BETWEEN R&D AND PRODUCTION
- APPLICATION OF COMPUTER TECHNOLOGY
- ECOLOGY AND SAFETY
- CONSERVATION

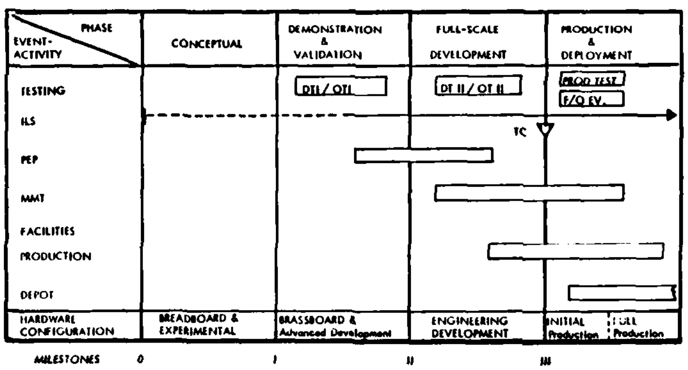
Our objectives are shown on this chart.

The first objective is to adapt the most advanced industrial technology of the US and foreign countries to the economic production of modern weapons systems.

The second objective of the program is to assist in the transition of new products from development to full-scale production.

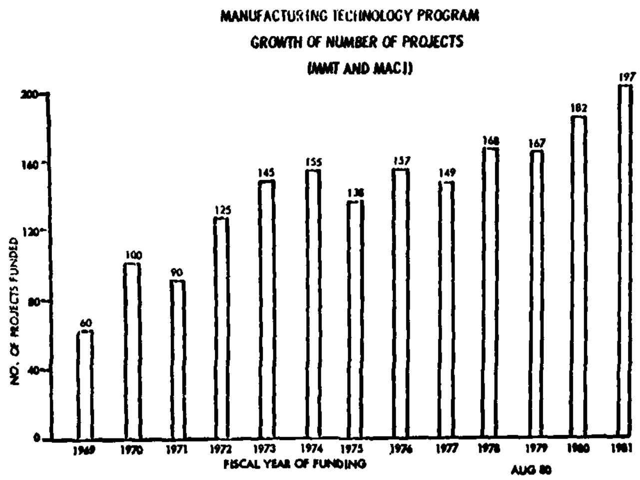
Other objectives include finding solutions to specific technological problems including occupational health and safety, pollution abatement, conservation of materials and energy, and unique problems associated with the manufacture of specific commodities, assemblies or piece parts.

LIFE CYCLE MANAGEMENT MODEL

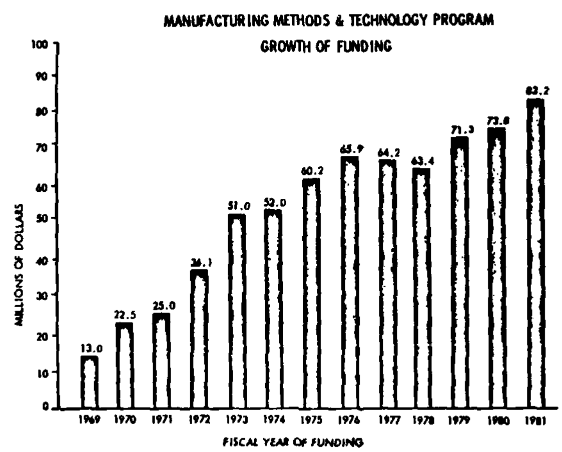


The Arm. approach to manufacturing technology is to make it an integral part of the product life cycle from advanced development through full-scale production. The effort is initiated with the RDT&E funded Producibility Engineering and Planning (PEP) program. Under this program, producibility of the product is evaluated and influenced, production line layouts are developed and potential manufacturing problem areas are identified.

The manufacturing methods and technology program is used to adapt and prove the suitability of processes, techniques and equipment for industrial production and depot rebuild operations.



Now let's look at the number of projects funded by the Army during the period from 1969 through 1981. The program has experienced a growth of over 300 percent during the period despite the increasing complexity of individual projects and technology.



The growth in the number of projects was accompanied by a 640 percent growth in funding during the same period but we had no real growth in FY 79, 80 or 81. The slight decline in FY 77 and FY 78 represents a reordering of priorities in the ammunition program. In FY 79 and FY 80 our program was restructured from a program of generic projects with broad weapons applications to one that concentrates on generic technology for specific weapon systems; ones that are likely to consume most of the Army's procurement dollars over the next several years. The FY 82 budget shows the impact of that restructuring and it carries through for the entire five-year period from FY 82 to FY 86 as I'll show later.

ACTIVE MMT PROJECTS
FY80 AND PRIOR YEARS

	NUMBER OF PROJECTS	VALUE $M
AIRCRAFT	72	19.7
MISSILES	64	23.8
TCV & WEAPONS	101	26.4
AMMUNITION	181	106.1
OTHER	129	73.0
TOTAL	547	249.0

This chart shows the active MMT projects, by major appropriation. As of 27 August 1980 we had 547 active projects with an approved value of $249 million. Ammunition, our Tri-Service Program, accounted for approximately 33 percent of the projects and 42 percent of the funds.

MANUFACTURING TECHNOLOGY PROGRAM
FY81
($ MILLIONS)

APPROPRIATION	MMT + MACI
• AIRCRAFT	10.6
• MISSILES	10.6
• TCV & WEAPONS	12.5
• AMMUNITION	21.8
• OTHER	27.7
TOTAL	83.2

SOURCE: FY81 DA APPORTIONMENT REQUEST, MAY80

This chart shows the distribution of the FY 81 program among the five Army appropriations. The "Other Appropriation" which includes support equipment such as electronics and communications equipment, is the fastest growing portion of the budget, accounting for nearly 33 percent of the FY 81 program. The next chart shows a breakdown of the "Other Appropriation."

MANUFACTURING TECHNOLOGY PROGRAM,
OTHER PROCUREMENT APPROPRIATION
FY81
(MMT AND MACI)

	($ MILLIONS)
ACTIVITY 1	4.5
o TACTICAL AND SUPPORT VEHICLES	
ACTIVITY 2	8.5
o COMMUNICATIONS AND ELECTRONIC EQUIPMENT	
o NIGHT VISION DEVICES	
o ELECTRONIC AND MICROWAVE COMPONENTS	
o COMMUNICATION DEVICES	
o IC TECHNOLOGY	
ACTIVITY 3	14.7
o MATERIALS AND PRODUCT TESTING TECHNOLOGY	
o METROLOGY AND CALIBRATION TECHNOLOGY	
o ENGINEERING HANDBOOKS	
o TROOP SUPPORT EQUIPMENT	
TOTAL	27.7

The other appropriation is made up of the three activities shown here. Activity 1 covers processes for manufacture of tactical and support vehicles. Activity 2 covers communications and electronics equipment and Activity 3 covers miscellaneous activities. One of these activities is troop support equipment which includes such items as gas masks and other defensive equipment.

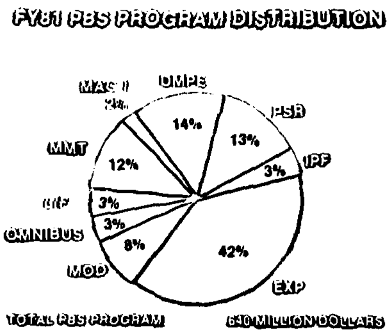
MAJOR THRUSTS
FY 81 MMT PROGRAM
$83.2 MILLION

- MANUFACTURE OF COMPOSITES
- DEVELOP AND IMPLEMENT AUTOMATED INSPECTION/ TEST/DIAGNOSTIC METHODS
- DEVELOP PROCESSES FOR SEMICONDUCTOR MATERIALS
- POLLUTION ABATEMENT AND ENERGY CONSERVATION
- COMPUTER INTEGRATION OF ELECTRONIC MANUFACTURING
- PLANT MODERNIZATION

A cross section of the major thrusts of the FY 81 program are shown on this chart.

Automation of processes, advanced process control, inspection technologies and labor efficient materials handling systems will be emphasized along with pollution abatement and energy conservation.

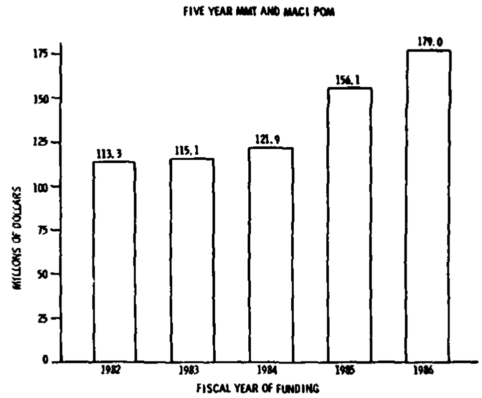
Programs range from the manufacture of composites to better processes for semiconductors to plant modernization. The composites are mostly for aircraft: the semiconductors for night vision devices and high density integrated circuits: and the plant modernization for ammunition, weapons, and depots.



The Army is committed to both a MANTECH program and a capital investment program for production facilities in areas where private capital is not available. Manufacturing technology is the keystone to that capital investment program and its primary source of new technology. The overall FY 81 program is $640 million.

The acronyms are explained below:

MMT - Manufacturing Methods and Technology.
MACI - Military Adaptation of Commercial Items.
DMPE - Depot Maintenance and Production Equipment
PSR - Production Support and Replacement (For existing Army owned Production Facilities).
IPF - Initial Production Facilities
EXP - Expansion of Production Facilities (Normal Follow-On to IPF).
MOD - Modernization of Existing Facilities.
OMNIBUS - Engineering to Design New Production Lines whether Financed and Built by Industry or the Army.
LIF - Layaway of Industrial Facilities (No current production but required for emergencies or other future requirements).



This chart shows the Army's planned program for FY 82 through FY 86. You'll note the sharp increase from $83.2M in FY 81 to $113.3M in FY 82 and the continued upward trend throughout the balance of the period. This is an uninflated program built on the "Support of Weapons Systems" concept.

FIVE YEAR MMT AND MACI PLAN

FY82 - 86

FORECAST: $137 MILLION/YEAR

- AIRCRAFT 13.2%
- MISSILES. 8.1
- TCV & WEAPONS. 20.2
- AMMUNITION 27.5
- OTHER. 31.0

SOURCE: POM

The distribution of funds among the various commodities during the FY 82-FY 86 time frame is shown here. Funds will be available to capitalize on opportunities in each major area with the "Other Appropriation" consuming the largest share of all MMT funds.

MANAGEMENT EMPHASIS

- PROGRAM GUIDANCE
- PRODUCTION COST DRIVER ANALYSIS
- COORDINATION WITH WEAPONS DEVELOPER
- COORDINATION/INTERACTION WITH INDUSTRY
- TECHNOLOGY TRANSFER
- IMPLEMENTATION OF RESULTS

The important areas of managerial emphasis are shown on this chart. Our program guidance is more definitive than ever before to include priorities, suggested areas for investment, potential joint efforts, and guidelines for planned implementation of completed projects.

We are also emphasizing cost driver analyses, improved coordination with the weapons developer and industry and more attention to technology transfer and implementation.

Immediately upon completion of this conference we are going to embark on a program to simplify our whole system of project justification and reporting. We've been nibbling at this problem for a year and the time has come to attack it head on.

FACTORS DETERMINING PROJECT PRIORITIES

- REQUIREMENTS
  - PEACETIME PRODUCTION
  - MOBILIZATION
- POLLUTION ABATEMENT
- ENERGY CONSERVATION
- IMPROVED SAFETY
- ECONOMICS

This chart shows the factors that drive project priorities in the program. These factors were selected because they are essential considerations in planning good projects.

Requirements are particularly difficult to pin down because they are dynamic. Changing military threats, budget constraints, the number of sources of supply, and many other factors influence requirements causing us to work and rework this part of the equation. None-the-less, it's such an important factor in the technology and capital investment strategy that one must make an informed judgement in order to proceed.

VISIBILITY OF PLANNED PROGRAM

- 5 YEAR PLAN
- INDUSTRY BRIEFINGS BY COMMANDS
- MTAG TRI-SERVICE SUBCOMMITTEE MEETINGS
- INDUSTRY ASSOCIATIONS

We believe our MANTECH program is best served by keeping our plans and needs highly visible both internally and externally. Last January we developed and published a five year plan mapping the future course of the program. This plan will be updated annually and is available through our MANTECH office or IBEA for your information and critique.

The information flow is also accomplished through industry briefings at the subordinate commands of DARCOM, MTAG Tri-Service subcommittee meetings and through participation in industry associations.

PRODUCTION COST DRIVER ANALYSIS

- MAJOR AND MINOR SYSTEMS
- COST DRIVER CONFERENCES
- ANALYZING THE FACTORY

Production cost driver analysis is a technique being used throughout the Army to identify fruitful areas for MT work. Conferences with industry such as the one held in March 1980 on Aircraft, have effectively exploited this technique to identify needed MANTECH projects.

As we put the MANTECH program to work to improve the productivity of production facilities for new weapon systems, it is being used in the analysis of the factories that will build those weapons.

COORDINATION WITH WEAPONS DEVELOPER

- JOINT R&D ADVANCED PLANNING/MANTECH BRIEFINGS TO INDUSTRY
- MANTECH INPUT TO EARLY PRODUCT DESIGN
- PARTICIPATION IN PRODUCIBILITY ENGINEERING AND PLANNING PROGRAM
- PARTICIPATION ON CONFIGURATION AND PRODUCT IMPROVEMENT BOARDS

The manufacturing technology program is being made an integral part of our weapons development program commencing with the advanced planning briefings to industry. Manufacturing Technology engineers are expected to participate in the research and development programs through producibility engineering and planning studies and membership on configuration management and product improvement boards. The objective is to generate an environment in which designers will include the manufacturing process as a natural part of their design decision making. We cannot afford the time or expense of redesigning and retesting sophisticated weapons for production.

COORDINATION WITH INDUSTRY

- MTAG
- SEMINARS AND CONFERENCES
- ARMY PUBLICATIONS
- END OF PROJECT DEMONSTRATIONS

Coordination with industry is fundamental to the success of our program. That coordination is being accomplished thru this forum, seminars and conferences and DARCOM publications such as the MANTECH Journal, and manufacturing technology bulletins, notes and tabloids.

This is a two-way street, of course, and we welcome your suggestions for projects, inquiries on work we have completed or have underway and general suggestions to improve the program.

IMPLEMENTATION AND TECH TRANSFER

- MICOM TRIAL EVALUATION ON MT IMPLEMENTATION
- SOURCES FOR MANTECH INFO
  - NATIONAL TECHNICAL INFORMATION SERVICE
  - DOD TECHNICAL INFORMATION CENTER
  - OFFICE OF MANUFACTURING TECHNOLOGY
- MTIAC STUDY
- ANNUAL MTAG DOD-INDUSTRY MEETING
- MTAG SUBCOMMITTEE ACTIVITIES

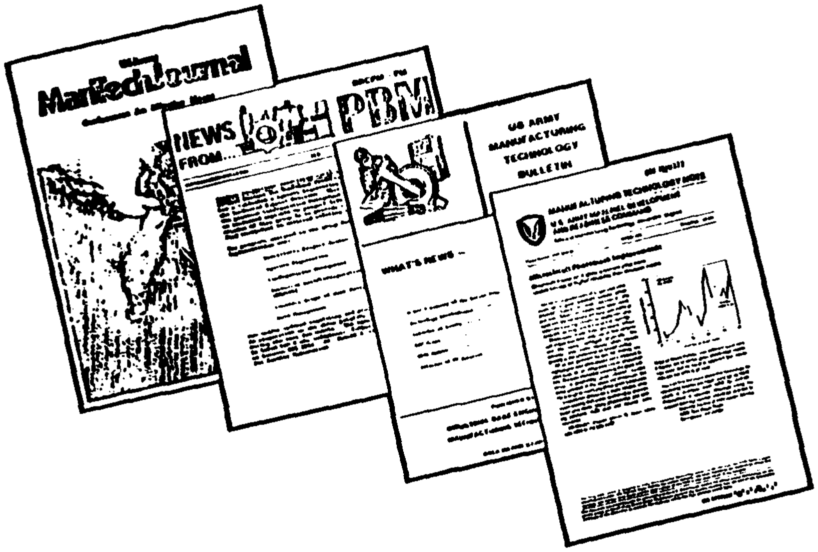
Implementation and technology transfer have been the weakest part of the MANTECH program throughout DoD. All of us in the defense MANTECH community have spent a great deal of time this past year in searching for solutions to the problem.

The US Army Missile Command (MICOM) is incorporating a requirement for implementation into its MANTECH contracts. This experiment is being conducted on a trial basis to evaluate the effectiveness of the approach. Implementation plans are now required at the completion of all projects.

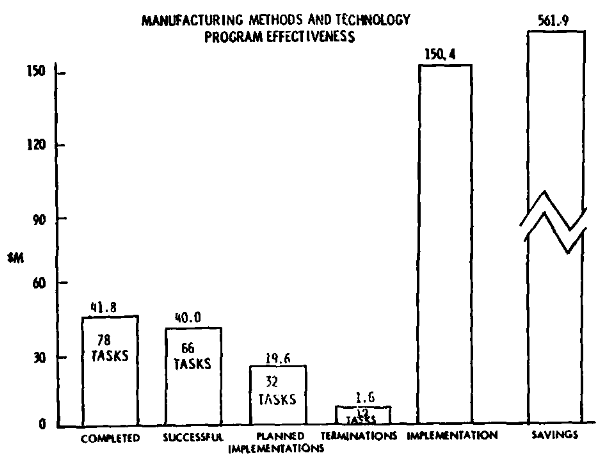
Sources of MANTECH information are shown at the center of the chart and we invite you to use them as often as needed. If in doubt, write the office of manufacturing technology at DARCOM and we'll help you.

A study is currently underway to evaluate the feasibility of a Manufacturing Technology Information Assessment Center (MTIAC). If established, the center will be a dedicated source of technology. Last, but not least, are MTAG and the associated activities.

TECHNOLOGY TRANSFER



Shown here are the front pages of four Army publications used to publicize our accomplishments. They include the ManTech Journal, U.S. Army ManTech Bulletin, the U.S. Army ManTech Notes and news from the Production Base Modernization Agency. They are available for distribution to both government and industry.



Data from implementation plans of successful projects completed during the six-month period from 31 December through 30 June 1980 are shown here. $41.8M worth of projects were completed, $40.0M worth of 96 percent were technically successful and $19.6M worth or 47 percent have planned implementation. The remaining 3 percent were terminated. The implementation costs were estimated at $150.4M. Savings of $561.9M will be realized resulting in a return on investment of 2.9 to 1.

This next series of charts show examples of successful projects from the Army's prior year program. The charts are self explanatory.

DARCOM PRIOR YEAR MM&T IMPLEMENTATION
TURBINE ENGINE COMPONENTS

EFFORT NO: 1 XX 7103

TITLE: IMPROVED MANUFACTURE OF TURBINE ENGINE COMPRESSOR COMPONENTS

COST: $740,000

IMPLEMENTATION COST: $14M

BENEFITS

THIS PROJECT DEVELOPED MACHINERY AND PROCESSES FOR PRODUCTION OF TURBINE ENGINE COMPRESSOR COMPONENTS THAT HAD NEVER BEFORE BEEN MANUFACTURED. APPLICATION WAS SHOWN ON THE BLISK AND IMPELLER FOR THE T700 ENGINE.

IMPLEMENTATION ON THE T700 PRODUCTION LINE AT THE GENERAL ELECTRIC PLANT WILL COST $14 MILLION, BUT WILL SAVE $16,000 PER ENGINE OR $60 MILLION AT THE SCHEDULED PRODUCTION RATE.

DARCOM PRIOR YEAR MM&T IMPLEMENTATION
EXPLOSIVE RECOVERY

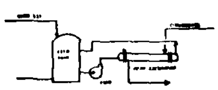
EFFORT NO: 5 74 4205

TITLE: PROCESSING SPENT ACID FROM RDX/HMX REACTION FOR RECOVERY OF EXPLOSIVES

COST: $70,000

BENEFITS

THIS PROJECT INSTALLED A HEATING AND CIRCULATING LOOP ONTO THE PRIMARY EVAPORATOR FEED TANK IN THE SPENT ACID RECOVERY PROCESS AT HOLSTON AAP.



PRIMARY EVAPORATOR FEED TANK

THIS HEAT EXCHANGER INCREASED THE SOLUBILITY OF RDX/HMX IN THE SPENT ACID, THUS DECREASING THE EXPLOSIVE LOAD LIMIT OF THE LINE. ADDED BENEFITS INCLUDE $11,000/YEAR STEAM COST SAVINGS FROM RECOVERING CONDENSATE. ALSO, THE HOT FEED PREVENTS BUILDUP OF CRYSTALLIZED RDX ON PIPE WALLS.

DARCOM PRIOR YEAR MM&T ACCOMPLISHMENT
LOCASERTS

Figure 1
COMPONENTS IN LOCASERTS

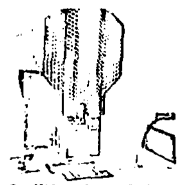


Figure 2 - INSERTION MACHINE

PROJECT NO: 3 76 3226

TITLE: PRODUCTION METHODS FOR MOUNTING NON-AXIAL LEAD COMPONENTS

COST: $195,000

RESULTS

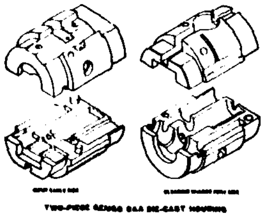
- MARTIN-MARIETTA CORP. ENHANCED AUTOMATIC INSERTION METHODS FOR NON-AXIAL LEAD ELECTRONIC PACKAGES: DUAL-IN-LINE, (DIP), PIN THROUGH HYBRIDS, AND TO-TYPE CANS.
- THEY DEVELOPED A PLASTIC, INJECTION MOLDED, LOCATOR-INSERTER (LOCASERT) PAD AND A COMPONENT INSERTION MACHINE TO POSITION THIS PAD.
- LOCASERTS REDUCE PRINTED CIRCUIT BOARD (PCB) ASSEMBLY TIME AND COST ON ALL LEVELS FROM MANUAL TO COMPLETE AUTOMATION.
- IMPLEMENTATION OF THIS PROJECT WILL RESULT IN AN ESTIMATED SAVINGS OF $780,000 PER YEAR.

DARCOM PRIOR YEAR MM&T ACCOMPLISHMENT
DIE CAST HOUSINGS

PROJECT NO: 5 77 4416

TITLE: DEVELOP AND PROVEOUT OF ALTERNATE MANUFACTURING PROCESSES FOR S + A

COST: $120,000



RESULTS

THIS PROJECT PROVIDED THE FABRICATION AND VERIFICATION TESTING OF AN ALTERNATE SAFE AND ARMING HOUSING FOR USE IN THE GEMSS MINE SYSTEM. OTHER APPLICATIONS OF THIS HOUSING ARE GATOR AND MOPMS.

THIS DIE CAST PART IS CONSIDERABLY SIMPLER AND LESS EXPENSIVE THAN THE BAR STOCK FABRICATED PART.

IMPLEMENTATION OF THIS PROJECT WILL RESULT IN ESTIMATED SAVINGS OF $1.6 MILLION PER YEAR.

FUTURE GOALS

- IMPLEMENT COMMAND-WIDE MIS SYSTEM FOR PROGRAM CONTROL
- SIMPLIFICATION OF BUDGETING AND REPORTING SYSTEMS
- INCREASE SUPPORT TO WEAPONS SYSTEMS
- INCREASE PARTICIPATION BY INDUSTRY
- BECOME TECHNOLOGY DRIVER FOR CAPITAL INVESTMENT PROGRAM
- ENCOURAGE GREATER USE OF IR&D PROGRAM FOR MT

The future goals of the Army program are shown here. We want to fully utilize the management information system designed and brought on stream in 1979. That system provides a capability for improved program control and technology transfer. We plan to simplify documentation and reporting requirements by eliminating unused reports, requirements for duplicate information, etc. The current system was designed a decade ago for a much less sophisticated program than we have today.

Last year just over 60 percent of the program was contracted to industry; we would like to increase that to 65 percent or more, keeping in-house only those dollars necessary to supervise and validate the results of the projects.

The independent research and development program is a good tool for ManTech and we encourage its use for that purpose.

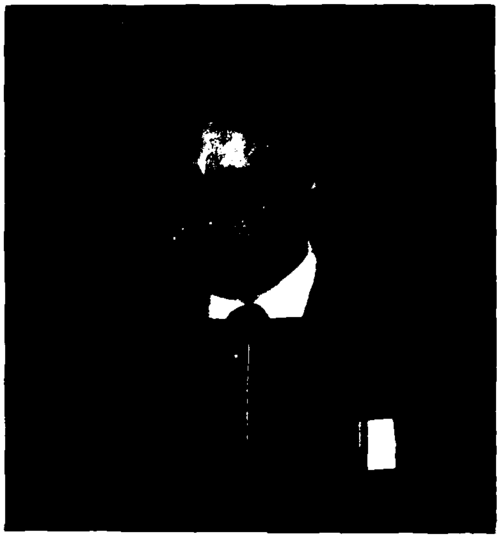
PRODUCTIVITY IN THE 80'S

. . . USE OF TECHNOLOGY TO REDUCE MANUFACTURING COSTS AND TO HELP IN THE RESOLUTION OF OUR OTHER BASE PROBLEMS IS A MAJOR RESEARCH, DEVELOPMENT AND ACQUISITION PROGRAM INITIATIVE FOR THE 1980'S . . .
. . . IMPROVED PRODUCTIVITY NOT ONLY EXERTS TREMENDOUS POSITIVE LEVERAGE ON DEFENSE SYSTEMS ACQUISITION AND LIFE CYCLE COSTS BUT ALSO IS A BASIC ELEMENT OF ECONOMIC GROWTH. . .

W. GRAHAM CLAYTOR, JR.
MEMO FOR THE SECRETARIES OF THE
MILITARY DEPARTMENTS, MAY 1980

In closing, we believe the Army Program is on course to achieve the "Productivity in the 80's" envisioned by Secretary Claytor when he made these statements in a memorandum to the secretaries of the military departments.

Thank you!



NAVY OVERVIEW

by

CAPTAIN FRED HOLLICK

Director, Manufacturing Technology Program
Naval Material Command

#1 VU GRAPH (MTAG 80)

Good Morning Ladies and Gentlemen. It is a privilege for me as the director to present an overview of the Navy's Manufacturing Technology Program. For some of you who have attended previous MTAG's, portions of my presentation may be "Old Hat", but for those of you who are attending your first MTAG, I hope my presentation will give you an insight into the Navy Manufacturing Technology Program. Despite some apparent funding problems, which I will discuss shortly, the Navy considers Manufacturing Technology to be an extremely important discipline with a demonstrated potential for reducing procurement and life cycle costs. The Navy's formal Manufacturing Technology Program is a rather new effort in comparison to our sister services and as such has and will exhibit growing pains.

#2 VU GRAPH (WEAPONS SYSTEMS COST)

Significant increases in the procurement, operations and maintenance costs of weapon systems have been experienced during the past decade. Inflation, increased sophistication of new weapon systems and decreasing productivity were the primary reasons. The situation was further compounded by a declining defense budget when viewed in terms of constant dollars.

#3 VU GRAPH (US vs THEM)

Soviet Military Procurement, R&D and Construction Spending was 85% greater than that of the U.S. They are constructing a wide variety of large open ocean offensively capable cruisers, carriers, logistic support ships, amphibious assault ships and submarines. In aggregate numbers, they already have about a four-to-one edge over the U.S. Navy. Their quality in many instances is close to meeting or exceeding that of the U.S. Their ships and Air - Launched Missile Weapons are approaching those of the U.S. in technological sophistication.

The Navy's fiscal year 1981 budget has no real growth in it (after adjusting for inflation) and must absorb some $1 billion in higher than anticipated Mideast activity. Plans are still more on paper than in hardwarre to rebuild an inventory of ships that has been reduced by half over the last decade. The Chief of Naval Operations, Admiral Haywood, has stated "We have a one-and-a half ocean Navy trying to meet a three ocean commitment."

#4 VU GRAPH (FORCE LEVELS)

Basically, we are saying that force levels in the Navy are being dictated by what we can afford, reduced costs and improved productivity without sacrificing quality or capability would enhance force levels. I believe that Manufacturing Technology is one of the most effective means at our disposal to directly control manufacturing costs.

#5 VU GRAPH (BRIEFING CONTENT)

This morning I will summarize for you the status and outlook of our Manufacturing Technology Program and tell you where the Navy is and where it is going. Specifically, the briefing will cover:

ORGANIZATION

FUNDING

PAST PROGRAM EMPHASIS

RECENT ACCOMPLISHMENTS

NEW PROGRAM EMPHASIS

AND THE EVER POPULAR SUMMATION

#6 VU GRAPH (ORGANIZATION)

To accomplish the Manufacturing Technology Program, the Navy applies a lean three tier, highly functional organization. Management of the Navy Manufacturing Technology effort is centered in my office, namely, the Office of the Director under the Chief of Naval Material. The Naval Material Command Industrial Resources Detachment (NMCIRD) located in Philadelphia represents and provides support to me in the areas of technical review, technical coordination and administrative functions. This staff is composed of engineering specialists in the disciplines corresponding to the MTAG technical subcommittees. Each systems Command (Naval Air Systems, Naval Electronic Systems and Naval Sea Systems) has a Manufacturing Technology Office which supports the Director. These offices are responsible for the planning, execution and implementation of that portion of the Manufacturing Technology Program within their spheres of interest. The Navy field activities, such as laboratories and engineering centers, support the three systems commands directly through engineering efforts or contract monitoring.

#7 VU GRAPH (ORGANIZATION & PROJECT PROGRESSION)

A frequent question asked by potential defense contractors first becoming aware of the Manufacturing Technology Program deals with the manner of submitting ideas or proposals. This Vu Graph shows how this may be accomplished. Superimposed on this organizational chart, is the way in which requirements (shown in red lines) are generated and projects (shown in blue lines) are established. The most direct method of receiving consideration for a possible project is through submission to a SYSCOM or field activity. Occasionally, a contractor may have a project which he feels is useful to several commands. He is uncertain as to where the submission should be made in order to maximize his chances for a contract. Two recourses are open to him. He may make multiple submissions to several SYSCOMS, or, if he wishes, direct his project proposal to NMCIRD Philadelphia. They will identify the most likely SYSCOM and refer the proposal for consideration. In all cases, NMCIRD will assure that duplication is avoided within the Navy or with other services.

Confirmed technology requirements are passed from NAVMAT to the SYSCOMS for full verification and substantiation. Performing activities define the projects to answer those requirements. Each SYSCOM has the responsibility and authority to prepare its own program, provided that it meets the overall requirements.

You may note that contractors play a significant role in the program. Also program offices and special study groups are active in the ordering of the requirements. Projects can originate anywhere.

#8 VU GRAPH (TECHNOLOGY TRANSFER)

The Navy policy is to publicize its Manufacturing Technology plans and accomplishments in order to attain as much participation and technology implementation as possible. Navy MT plans are indicated annually via distribution of a formal document which outlines proposed projects for the upcoming and five subsequent years. The document entitled The Five Year Plan provides a brief description of proposed MT projects, their objectives, present and proposed methods, benefits and funding levels.

This year, in an effort to promote additional participation in the Navy program, a new publication has been prepared for distribution. It is a technically oriented brochure which defines and depicts the Navy Manufacturing Technology Program. The brochure contains important information such as program objectives, MT organization, accomplishments, program background, points of contact, etc. It is hoped that it will stimulate and create a positive response to the Navy's program. Copies of the publication were available at the registration area. Anyone who needs a copy, if there are none left, can contact NMCIRD.

The Navy Manufacturing Technology Bulletin, prepared by the Naval Material Command Industrial Resources Detachment, is a publication utilized to publicize new technology, innovative ideas and new uses of these ideas and techniques throughout the services. It is published and distributed three to four times yearly.

Navy MT contracts provide for technology transfer by requiring contractors to conduct an End-Of-Project Demonstration. These are open to both government and industry.

#9 VU GRAPH (FUNDING)

Generally speaking, funding for the Navy Manufacturing Technology Program has been inconsistent over the last few years as evidenced by this Vu Graph:

	$M
FY 77	17.5
FY 78	10.8
FY 79	20.8
FY 80	25.6
FY 81	18.0

When one considers program funding levels as data points, it is easy to construct a curve which represents a roller coaster. To be sure, because of funding inconsistency, the Navy manufacturing Technology Program has had its ups and downs.

#9A VU GRAPH (FUNDING)

I have a variation of this Vu Graph I'd like to show you. If we can jump one last hurdle, the funding profile will look like this. Won't know until after the election ....

We are anticipating major improvements in program funding levels as the result of a recent meeting between the Chief of Naval Material and the Vice Chief of Naval Operations. The VCNO signed a

memo on 6 October 1980 stating, "I have decided on the following actions to place the Navy MT program on a more effective basis: OP-098 (our new sponsor) will ensure the FY 81 and FY 82 funding is protected so the Navy can establish a stable effort. Such an action should allow organizational and procedural patterns of responsibility to develop and should stimulate industry interest in participation."

#10 VU GRAPH (5-YEAR FUNDING)

This Vu Graph represents the anticipated level of funding in the outyears. It indicates an approximate $34 million in FY 82 increasing to $85 million in FY 86.

#11 VU GRAPH (FUNDING COMPETITION)

Part of the instability shown to date is due to growing pains associated with any new program. The Manufacturing Technology "Pay Back" is in future years. It is sometimes difficult to sell our decision makers the idea that it is prudent to invest current dollars for future benefits when you are competing with buying "Fuel-Ships-and Planes" for today's utilization.

#12 VU GRAPH (INDIAN OCEAN OPERATION)

For example, our FY 80 funding began the year at $25.6 million but the Indian Ocean operation has caused our program to be sliced by $10 million.

#13 VU GRAPH (MT FY 77 to 80)

From FY 77 to FY 80 the Navy has invested a total of $64.7 million in its Manufacturing Technology effort. This represents some 140 Manufacturing Technology projects, of which 27 have been completed. This Vu Graph shows the cumulative funding by technical category. Thirty-two percent of the dollars was spent in the electronics area with nonmetals and metals categories close behind at 27 and 24 percent respectively. The distribution is the result of the "Bottom-Up" flow of projects into the Navy for FY 77 and FY 78.

Both a top-down and bottom-up approach is currently utilized. The top-down approach is reflected in the investment opportunity studies which the Navy conducted in the areas of aircraft manufacturing and overhaul, shipbuilding and ship overhaul, weapon systems and electronics. These studies identified high cost areas and opportunities for Manufacturing Technology investments. SYSCOM's then tailored their projects in a bottom-up approach in response to these studies.

#14 VU GRAPH (ACCOMPLISHMENTS)

Although the Navy MT program has had some growing pains, we have successfully completed numerous projects over the last few years. I would like to take a few minutes to discuss several of our more recent accomplishments.

#15 VU GRAPH (PICTURE OF SHIP)

The Phalanx Close-In-Weapon System (CIWS) uses a series of three different microwave post filters which were prime candidates for applications of high strength, high temperature injection molded plastics. Machined metal filters of this type are very expensive due to the complexity of manufacture and are extremely difficult to calibrate due to widely fluctuating tolerances. Feasibility of utilizing plated plastic microwave post filters was successfully demonstrated with filters which indicated improved electrical characteristics in addition to projected cost savings over that of the machined metal filter.

#16 VU GRAPH (PICTURE OF FILTER)

To this end, a Manufacturing Technology Program was funded for the development of the production molding technology to fabricate the 13 element post filter in the Phalanx System. As the effort proceeded, it soon became apparent that the plastic filter improved overall performance: especially in the area of insertion loss.

A comparison of the producibility of the two filters revealed the need for a much larger equipment and capital outlay to produce the metal filter. Ease of producing the plastic plated filters is reflected in all phases from reduction ot operator errors, less scrap, to significantly less tuning time being required. A contract for the effort was completed with the General Dynamics, Pomona Division, in May of 1980. The 13 element post filter, which demonstrated this technology, was immediately adopted by the Phalanx Program Office and is currently being implemented in the gun system. Plans to utilize this technology for the additional two filters of similar construction are currently underway.

#17 VU GRAPH (BENEFITS)

Production costs of the plastic molded filter is $157 as compared to the machined metal

filter cost of $3,674 or a cost ratio of 23 to 1. Total savings, when projected to the number of filters (3 per system) in a total procurement of 463 Phalanx systems is $4,885,000 for an MT investment of $113,000.

#18 VU GRAPH (PICTURE OF PROPELLER BEFORE AND AFTER)

Another effort utilizing plastic molding techniques has been successfully completed on the MK46 torpedo propeller.

In the past, design specifications of torpedo propellers permitted only one method of manufacture, namely machining. With the advent of the advanced MK46 (NEARTIP) torpedo propeller design, which incorporated various cost reduction features such as fewer, thicker blades with blunter leading and trailing edges, it became feasible to investigate alternate manufacturing methods and materials to significantly reduce production costs. With feasibility of molding plastic torpedo propellers having been established, an MT effort was launched in FY 78 to transition the molding technique from the feasibility state to the production mode. This technique molds a fiber loaded polyester around an aluminum insert in a full segmented mold. Propellers produced by this method have acoustic benefits as well as cost advantages. The white propeller is plastic, the other aluminum.

#19 VU GRAPH (BENEFITS)

This MT project was completed in March 1980, at a cost of $287,000. It is estimated that the cost of a set of Neartip torpedo propellers (2 counter-rotating) will be reduced from $1500 (machined) to $360 (molded). Based on a procurement of 6300 Neartip torpedos through FY 85, the estimated total savings will be $7,180,000. This technology will be implemented on the next Neartip torpedo production contract.

The recent addition of an expendable decoy package to the Navy Arsenal surfaced the need for improvements in the manufacture of traveling wave tubes to lower costs.

#20 VU GRAPH (TUBE ASSEMBLY)

This is what an expendable traveling wave tube looks like.

It is about 15 inches long, 2 inches in diameter and weighs 2 pounds. This is the basic configuration in which the TWT would be supplied to the equipment manufacturer for incorporation into the transmitter.

As with most microwave components, this tube requires costly precision machining, fabrication and assembly and as a result is labor intensive. 80% of the $3658 unit cost is labor.

#21 VU GRAPH (BENEFITS)

The objective of this MT effort was to reduce the costs of manufacture of the expendable traveling wave tube that was to be used in the expendable decoy system.

A $2,260K funded effort managed by the Naval Research Laboratory in conjunction with the Raytheon Microwave and Power Tube Division has resulted in estimated savings of $4,932K based on a 6000 tube production run.

It is interesting to note that 40% of the methods and techniques developed thus far in this program are presently being used in similar TWTs for government use. It is anticipated that 90% of the methods and techniques will be used in similar tubes by the end of this effort.

#22 VU GRAPH (PICTURE OF CATHODE)

The "M" type dispenser cathode is used in high current traveling wave tubes, long life space traveling wave tubes, and low noise receiver traveling wave tubes.

The present method of "M" cathode manufacture is nonreproducible and gives low yield on acceptance tests.

This failure is associated with the peeling of a thin coating which is deposited on the cathode to give it superior emission properties.

#23 VU GRAPH (BENEFITS)

The objective of this effort was to reduce the reject rate by establishing process controls and technques, which would be reflected in an extended operating life of the receiver traveling wave tube used in the SLQ-32 system.

With an investment of $265,000 the Naval Research Laboratory in conjunction with SPECTRA-MAT

and SRI International determined that the peeling problem correlated with uncontrolled and excess coating thickness and excess carbon contamination before and during the coating deposition process.

Establishing a controlled coating process has increased cathode related yield of SLQ-32 TWTs from 20% to 100% and reduced manufacturing costs. Projected TWT life with the improved manufactured cathodes is 10,000 hours compared to 2,000 hours previously.

In the past up to 80% of the SLQ-32 TWT experienced early failure at a cost of $500 per tube. Extended life will return $1,000,000 based on procurement of 500 TWTs for the SLQ-32 system. A total of $5,000,000 savings may be anticipated from the full "M" cathode market during the next five years.

#24 VU GRAPH (NEW PROGRAM EMPHASIS)

Based on past performance and experience, major changes for meeting MT program objectives will be instituted. These involve program sponsorship, implementation and new initiatives.

#25 VU GRAPH (PROGRAM SPONSORSHIP)

Recently, Chief of Naval Operations' sponsorship of the Manufacturing Technology Program shifted from the logistics "side of the house" to surface and air warfare, coordinated by the Office of Research, Development, Test and Evaluation. Since the new sponsors approve and fund key planned procurements, this shift is judged to be most advantageous for Manufacturing Technology.

The shift of mission sponsorship to the Director of RDT&E will mean that the longer term payback and technological aspects of the program will be more in tune with both the inclinations and skills of their personnel. For us this means a reorientation and refocusing of the program content on the affordability issues.

More emphasis will be placed on key planned procurements. This will orient the program more towards the up and coming needs of the fleet and will at the same time maximize cost reduction and productivity.

#26 VU GRAPH (IMPLEMENTATION)

Implementation has been admittedly a weak area. In the future, project implementation will be an important objective which will be considered prior to initiation. The practice will be:

(1) To seek letters of implementation endorsement from the program managers. These letters are judged to be types of insurance policies which would guarantee implementation provided the efforts are successful and completed on time.

(2) To require implementation plans three months prior to project completion. This new requirement was instituted last year with the issuance of NAVMATINST.

In an attempt to strengthen implementation, general implementation plans, which will include letters of implementation endorsement from program managers will be required prior to project funding.

This requirement will be applied for the first time to the FY 83 program

Which brings me to .... New Initiatives.

#27 VU GRAPH (NEW INITIATIVES)

With new initiatives evolving in shipbuilding, weapons aircraft, and aircraft turbine engine manufacturing, we hope to reorient and revitalize the practice of manufacturing technology with the Navy.

I would like to provide an overview of some of the thinking behind two of the new initiatives, namely, shipbuilding and engine manufacturing.

#28 VU GRAPH (SHIPBUILDING TECHNOLOGY)

A shipbuilding technology program was picked as our first new initiatives because:

(1) It is the Navy's core Industry

(2) It is a strategic asset of central importance in building and maintaining a fleet

(3) It depends heavily on government business to maintain capacity and industry preparedness

(4) There is a pronounced deficiency in technology funding available to the industry

We are now in the very early stages of establishing this rather large manufacturing technology

effort. It has long been assumed that the process involved in building a ship is inefficient, labor intensive and unchangeable. With this assumption, programs have been initiated that have attempted to redefine the entire industry. They have failed. In the past, we have worked the bottom-up approach. We have attacked targets of opportunity and, although we may have had a reasonable return on investment, as far as ship acquisition costs are concerned, our savings have been relatively insignificant.

Our new initiative is based on the premise that in the past we got into the shipbuilding picture too late in the game. For Manufacturing Technology to be effective, we must get involved in the planning stages of shipbuilding, not in the construction phase.

We plan to have discussions with the entire shipbuilding industry concerning the following:

(1) Policies, practices, procedures and incentives that would insure active involvement of the industry in such an undertaking.

(2) Production, producibility and productivity problems facing the industry.

(3) Technological opportunities which are or could be made available given suitable funding to solve them.

That's where we are now, the talking stage, with most everyone in lock step.

#29 VU GRAPH (AIRCRAFT ENGINE MANUFACTURE)

As another initiative, the Navy will establish a comprehensive advanced Manufacturing Technology program specifically aimed at lowering the acquisition/life cycle costs of aircraft engines.

The recently completed Navy cost driver study on aircraft manufacturing and overhaul identified several areas of cost investment opportunities.

FY 82 funding of the Manufacturing Technology program will address these areas of interest.

#30 VU GRAPH (ENGINE COMPONENTS)

Initially, high performance engines will be the principal subject of this effort. Advanced materials and improved techniques are available for utilization. However, due to the lack of adequate manufacturing techniques, these advanced materials cannot be employed to their fullest. This leads to high Buy-to-Fly ratios, inadequate material lifetime, and excessive costs. It is proposed that Manufacturing Techniques will be established to allow for economic production of advanced components.

Specifically, projects to be undertaken are; the use of composites for fabricating engine outer duct and frame, the development of hollow super alloy shaft processing, establishing process for thermal barrier coating, improving the production processes for compressor seals, establishing techniques for corrosion resistant turbine blade tips, automation of an infrared inspection system for hollow turbine blades and vanes and the scale up of the rapid automated multistation directional solidification process for cast turbine blades.

The use of composite materials will provide significant weight reduction with structural equivalence of metals. Advanced blade materials will provide up to 2 to 3X life improvement. The use of Non-Metallic composites will reduce the demand for titanium.

Finally, it is expected that a program investment of $7.3 million will bring a return of $36 million in five years with $12 million accruing annually thereafter. These are a few of the benefits which may be realized under this program.

If you compare our program accomplishments with our new initiatives you will detect an entirely different breed of MT cat. We are attempting to organize in terms of a program concept rather than a project concept. Hopefully, this will cause a gleam in our sponsor's eye and result in support since he can more readily relate to the products rather than the processes involved in the Manufacturing Technology program.

#31 VU GRAPH (MANAGEMENT IMPROVEMENT)

During the past thirty minutes or so I have presented a brief overview of our total program. You have heard about the Navy's MT objectives, its organization, program emphasis, new initiatives and accomplishments. I would like to mention a few points regarding management of the program.

The Navy has underway several important steps to improve the management of its MT program. One such action is the development of a Management Information System (MIS). The Navy MIS will be compatible with the DOD information reporting requirements and will satisfy managment and operational needs. To date, progress has been made in the development of a data base to satisfy tracking and

reporting requirements.

Another action being taken is the formalizing of a project proposal ranking system. Until recently, Manufacturing Technology project ranking was informal, based on the interpretation of existing criteria. This varied from individual to individual, command to command. As such, it was almost impossible to equate similar technology projects, one against the other.

A draft of the ranking system has been prepared and includes basic categories such as production needs, implementation risk, technical risk, savings, return-on-investment and technology utilization. It is projected that initial utilization of this managment tool will commence later this year during evaluation of the FY 83 program.

Productivity Enhancing Capital Investment (PECI) is a program to increase productivity and decrease operating cost primarily at local commands by direct and immediate acquisition of capital investment items to modernize existing capabilities. This will counter manufacturing inefficiencies and stimulate more productive methods after Manufacturing Technology has provided the processing know-how and made the first machine or tool available.

The Navy MT Program Office works in close coordination with the Office of Productivity Management. This interaction serves to heighten visibility of MT efforts within the Navy and to evoke an emphasis on programs where pivotal productivity issues exist.

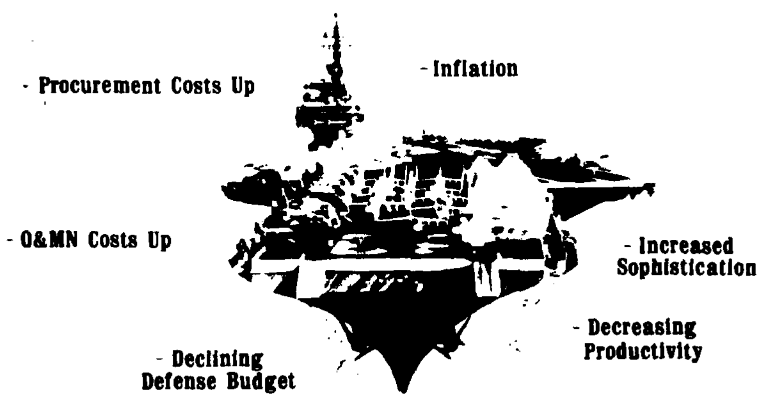
If the Navy's forces are to be maintained at levels to sustain mission essential requirements rather than what the Navy can afford, then government and industry must act together to best utilize available technology, capital and labor quality to attain those goals which best serve our country's defense needs. The program relies on a collaboration and communication between government and industry which can lead to mutual benefits. The program cannot survive without the active support and participation from both.

#32 VU GRAPH (PROGRAM OBJECTIVES/SUMMARY)

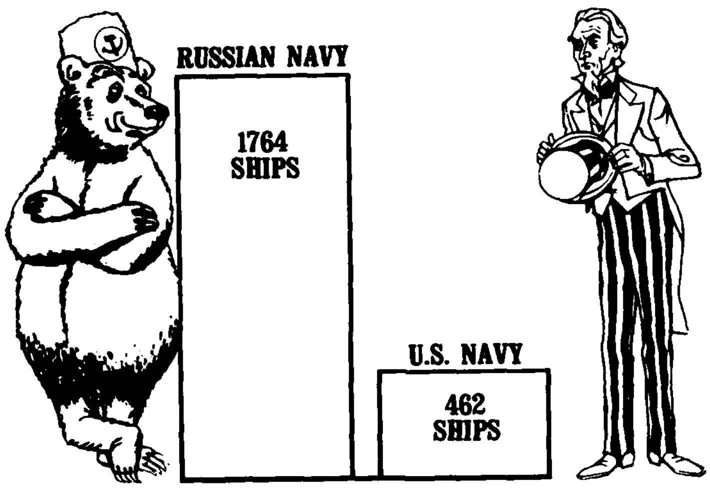
It may be stated that the objectives of the Navy Program Center is the reduction of costs required to support current and anticipated needs to the fleet. The aim is to do this through increased productivity derived from new technology applied in manufacturing. The Navy is moving toward a Manufacturing Technology Program based on needs, key technologies and economic benefits.

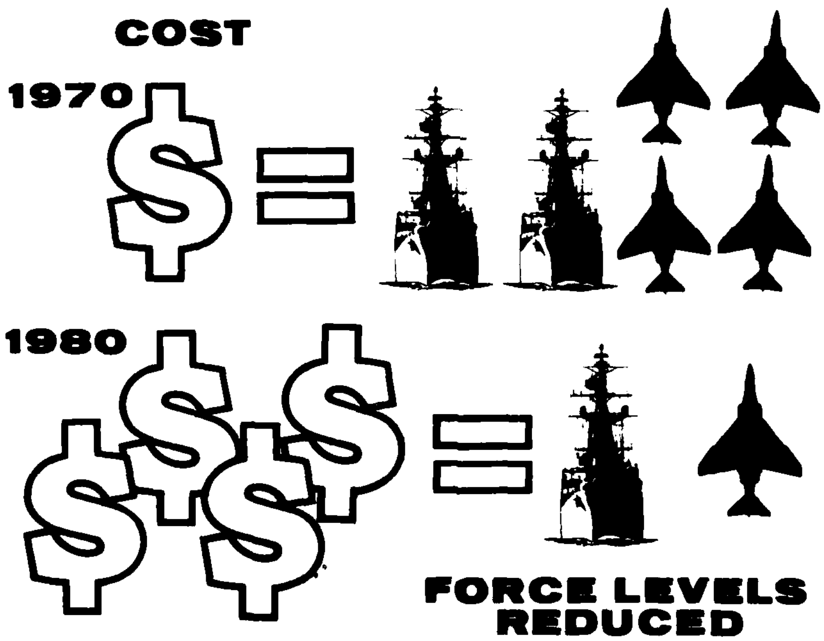
Finally, we feel that program outlook is good. Our experiences, both good and bad, have been worthwhile and based on these experiences, we look forward to improving our record and performance.

WEAPONS SYSTEM COST
1970 - 1980
$ $



Us Vs Them (1979)
NAVAL COMBATANT ACTIVE FLEET

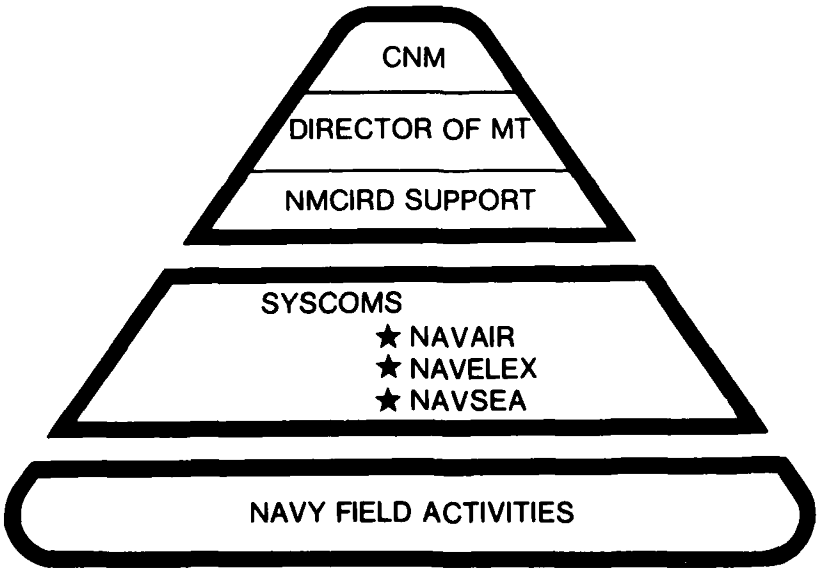


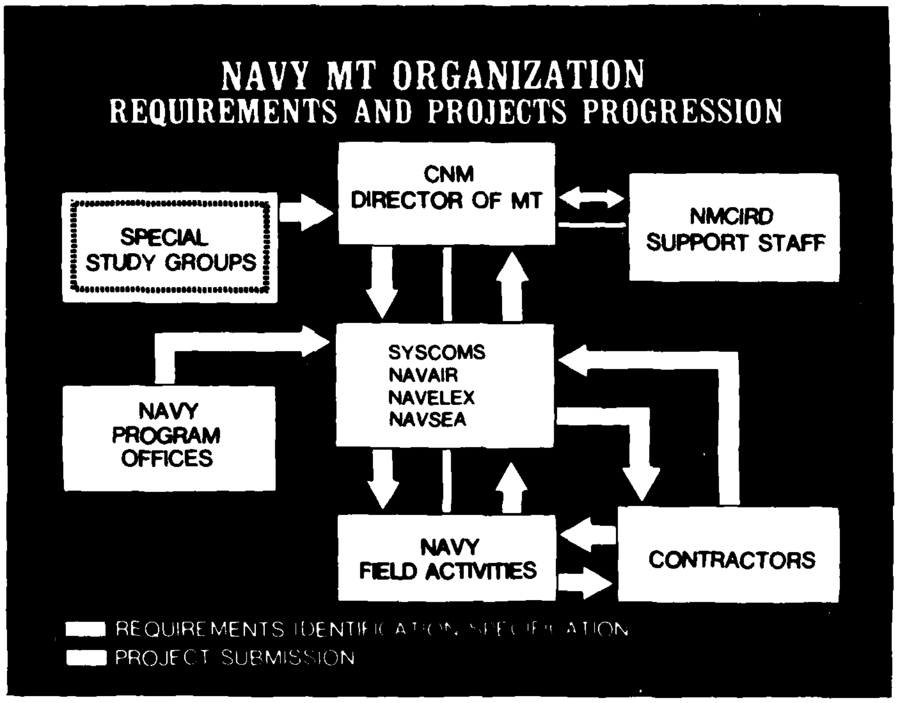


BRIEFING CONTENT

★ ORGANIZATION
★ FUNDING
★ PAST PROGRAM EMPHASIS
★ RECENT ACCOMPLISHMENTS
★ NEW PROGRAM EMPHASIS
★ SUMMATION

MT PROGRAM ORGANIZATION





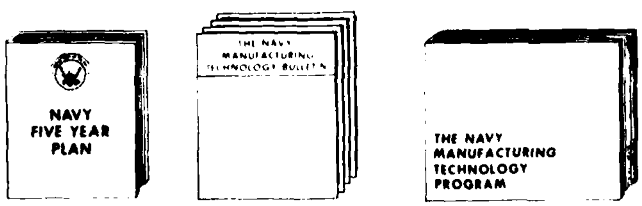
TECHNOLOGY TRANSFER

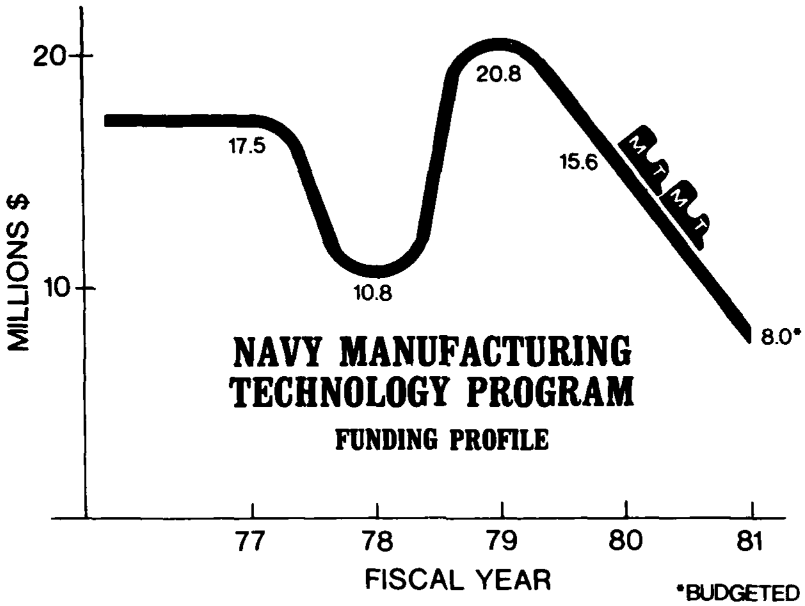
★ FIVE YEAR PLAN

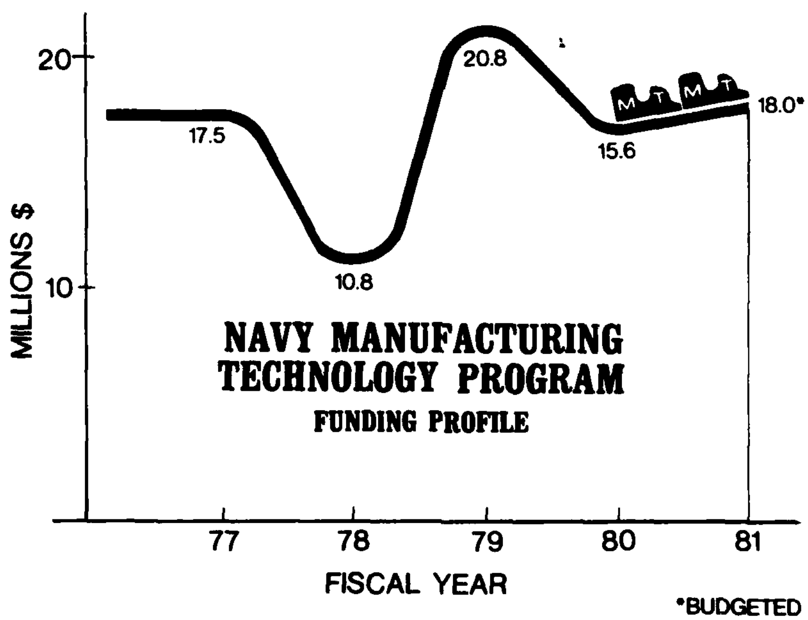
★ NAVY MT PROGRAM PUBLICATION

★ NAVY MT BULLETIN

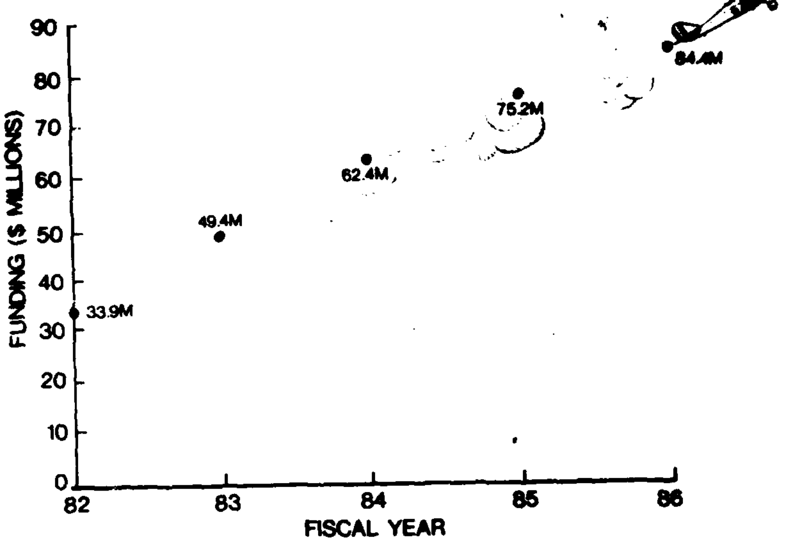
★ END OF PROJECT DEMONSTRATIONS




20
10
MILLIONS $
17.5
10.8
20.8
15.6
M T M T
8.0*
NAVY MANUFACTURING
TECHNOLOGY PROGRAM
FUNDING PROFILE
77
78
79
80
81
FISCAL YEAR
*BUDGETED

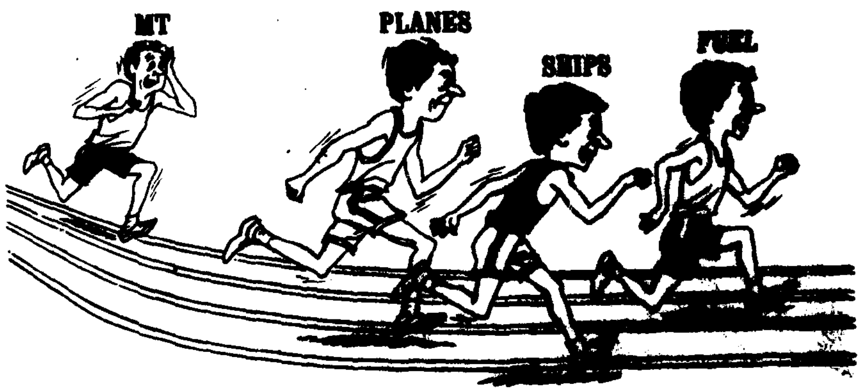

20
10
MILLIONS $
17.5
10.8
20.8
15.6
M T M T
18.0*
NAVY MANUFACTURING
TECHNOLOGY PROGRAM
FUNDING PROFILE
77
78
79
80
81
FISCAL YEAR
*BUDGETED

Navy Five Year MT Funding

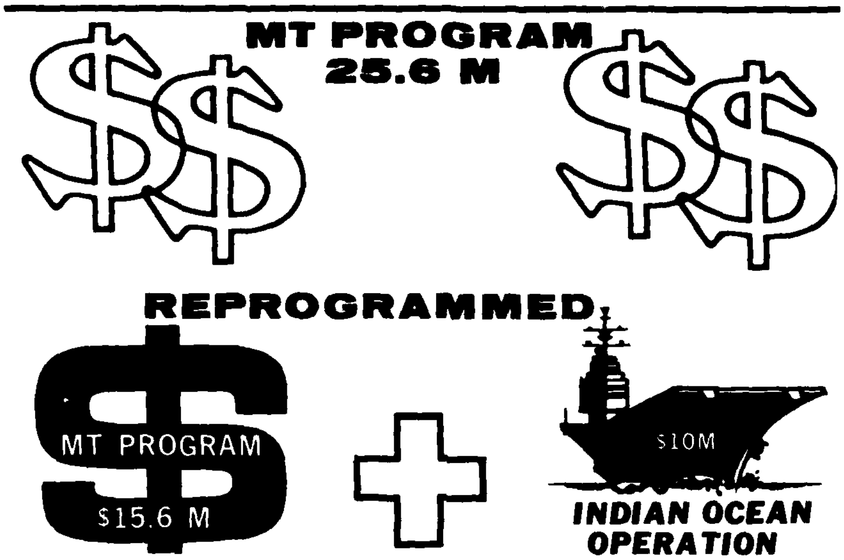


FUNDING COMPETITION

$ $



FY 80 MT FUNDING

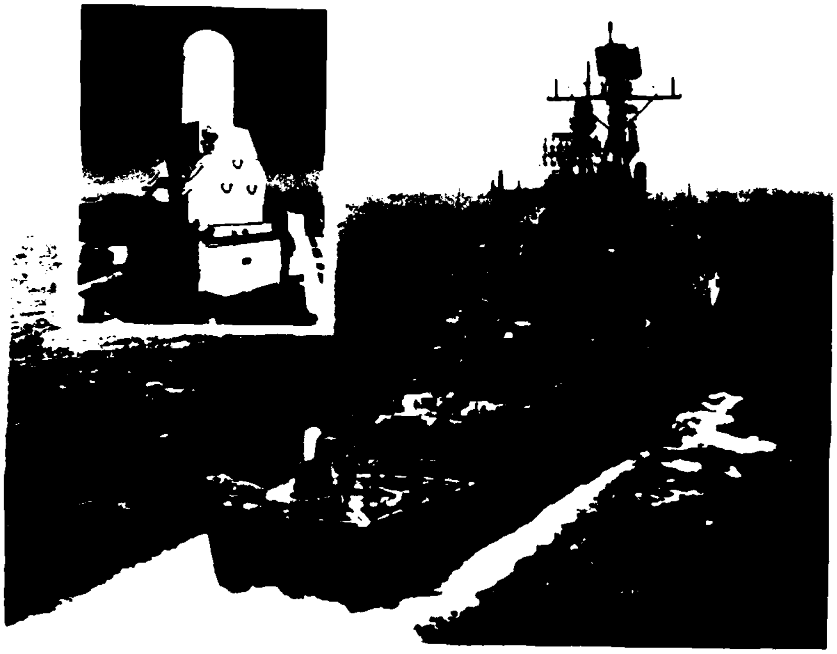


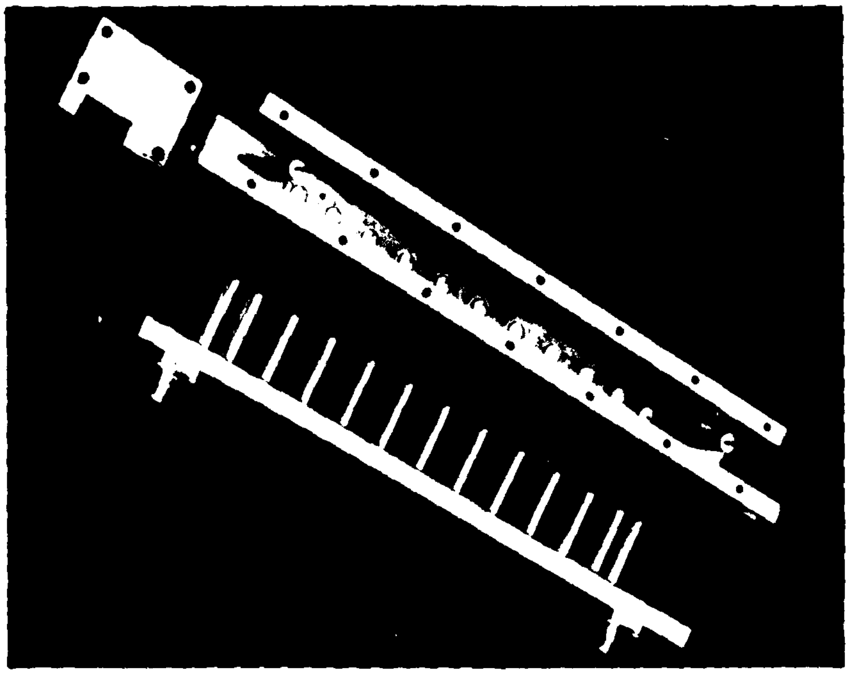
MT PROGRAM

FY 77 TO FY 80

★ **TOTAL INVESTMENT**		**64.7M**
ELECTRONICS	**32%**	
NON METALS	**27%**	
METALS	**24%**	
OTHER CATEGORIES	**17%**	
★ **NUMBER OF PROJECTS**		
FUNDED	**140**	
COMPLETED	**27**	
ONGOING	**113**	

ACCOMPLISHMENTS
ACCOMPLISHMENTS
ACCOMPLISHMENTS





PLASTIC MOLDED MICROWAVE FILTERS

OBJECTIVE:	REDUCE THE COST OF MICROWAVE FILTERS BY ESTABLISHING A PLASTIC MOLDING PROCESS
APPLICATIONS:	PHALANX CLOSE IN WEAPONS SYSTEM
PAYOFF:	INVESTMENT $113K SAVINGS $4,885K ESTIMATED FOR 463 PHALANX SYSTEMS

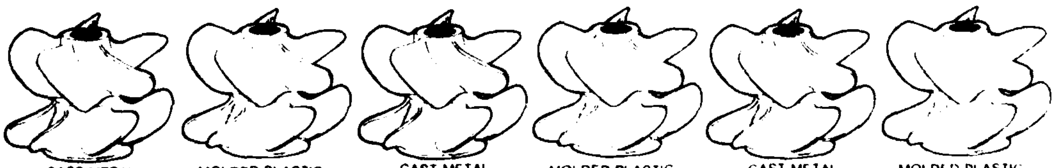
TORPEDO PROPELLER MANUFACTURE

OBJECTIVE: REDUCE THE COST OF TORPEDO PROPELLERS BY ESTABLISHING A PLASTICS MOLDING PROCESS

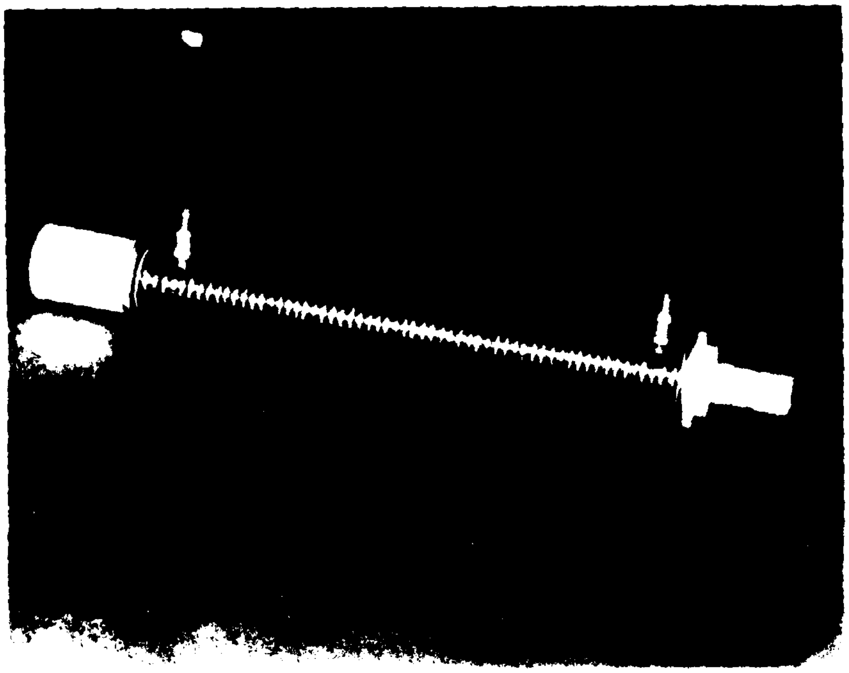
APPLICATIONS: NEARTIP (MK 46 TORPEDO)
ALWT
ADVANCED MK 48 TORPEDO

PAYOFF: INVESTMENT: $287 K

SAVINGS: $7,180K - ESTIMATED THRU FY85, BASED ON PROJECTED NEARTIP PROCUREMENTS ALONE

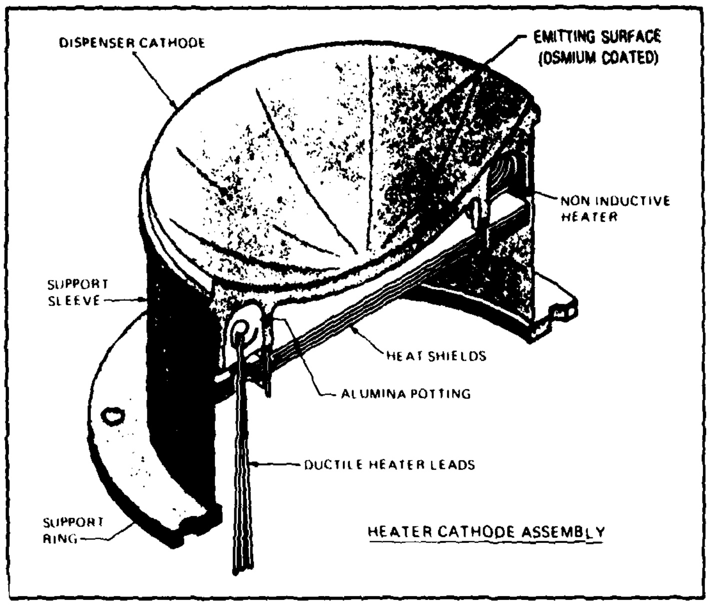


CAST METAL PRIOR TO MT | MOLDED PLASTIC MT | CAST METAL PRIOR TO MT | MOLDED PLASTIC MT | CAST METAL PRIOR TO MT | MOLDED PLASTIC MT



EXPENDABLE TRAVELING WAVE TUBE

OBJECTIVE:	REDUCE COST OF TWT MANUFACTURE BY ESTABLISHING NEW/IMPROVED MANUFACTURING METHODS/TECHNIQUES		
APPLICATIONS:	EXPENDABLE DECOY		
	OTHER GENERIC SYSTEMS		
PAYOFF:	INVESTMENT	$2,260K	
	SAVINGS	$4,932K	BASED ON 6000 TUBE PROCUREMENT



TYPE M DISPENSER CATHODE

"M" TYPE
DISPENSER CATHODE

OBJECTIVE: INCREASE OPERATING LIFE AND REDUCE REJECT RATE

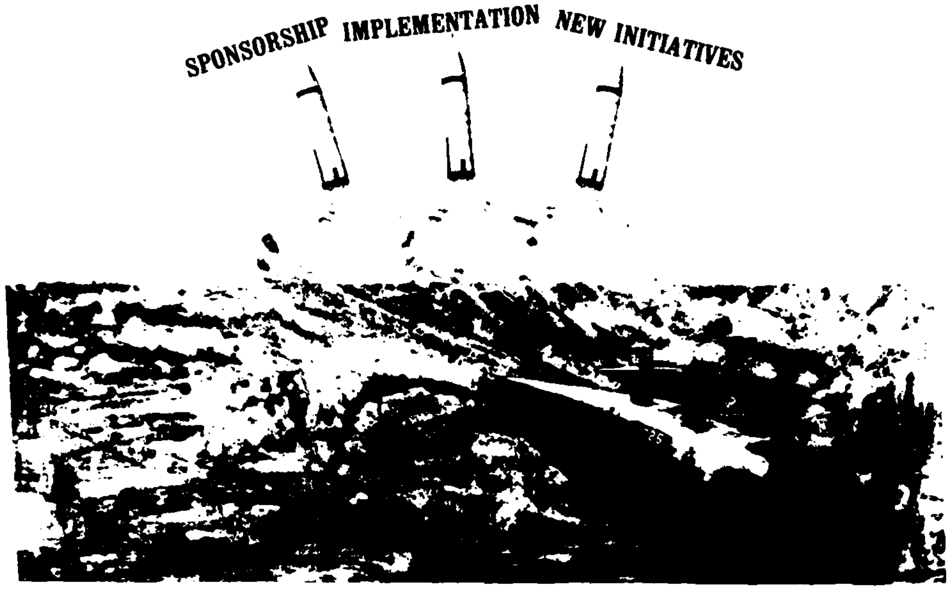
APPLICATION: SLQ-32 RECEIVER

PAYOFF: INVESTMENT - $265K

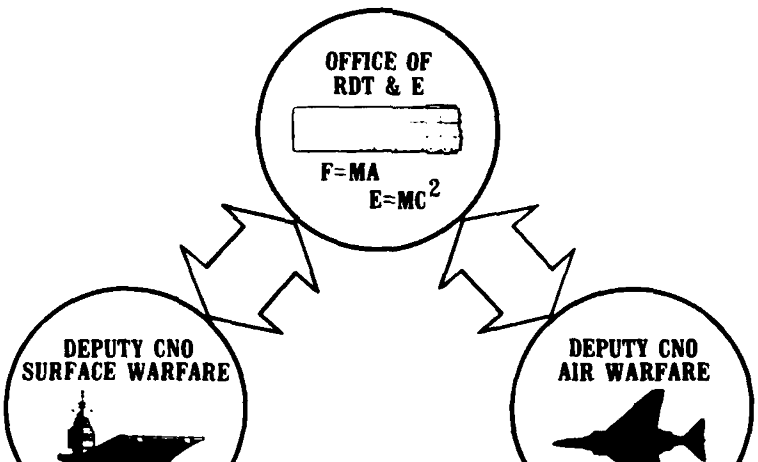
SAVINGS $1,000K BASED ON 500 TWTs FOR SLQ-32

$5,000K ACCRUING IN NEXT FIVE YEARS FROM FULL "M" CATHODE MARKET.

NEW PROGRAM EMPHASIS



PROGRAM SPONSORSHIP



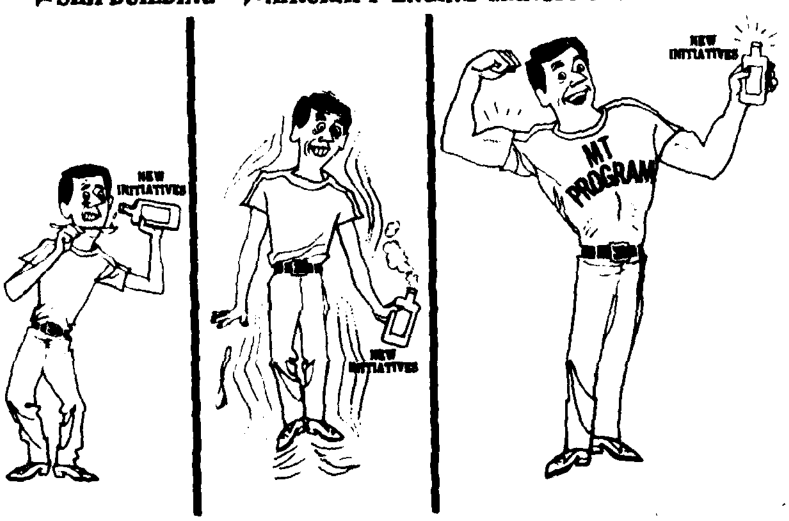
IMPLEMENTATION

★ LETTERS OF ENDORSEMENT

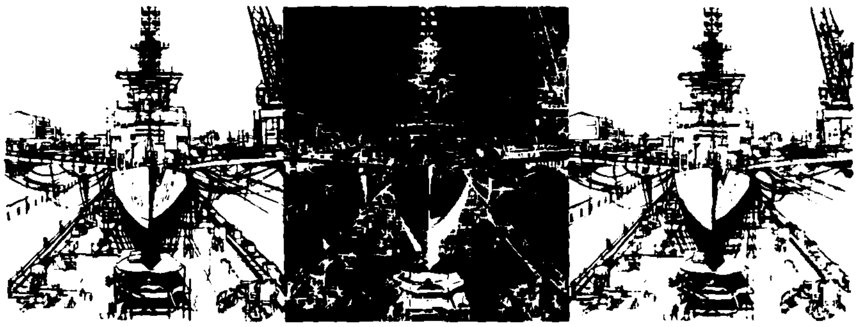
★ IMPLEMENTATION PLANS

NEW MT INITIATIVES

★ SHIPBUILDING ★ AIRCRAFT ENGINE MANUFACTURING



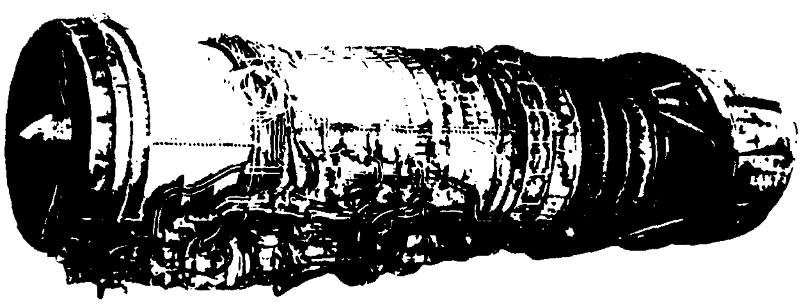
SHIPBUILDING TECHNOLOGY PROGRAM



- ✩ CORE INDUSTRY
- ✩ GOVERNMENT REQUIRED TO MAINTAIN CAPABILITY
- ✩ STRATEGIC ASSET
- ✩ TECHNOLOGY FUNDING DEFICIENCY

ADVANCED MANUFACTURING TECHNOLOGY

AIRCRAFT ENGINES

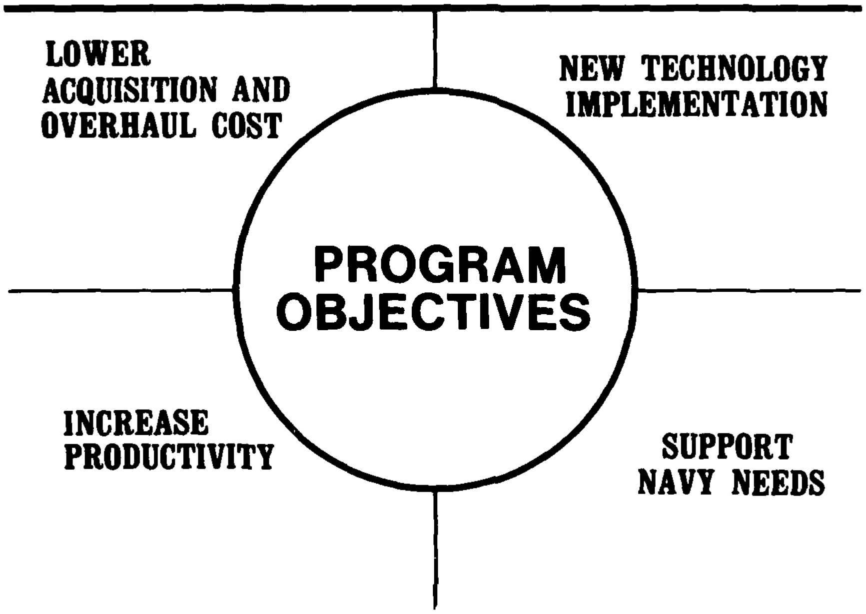


- ★ HIGH ACQUISITION/LIFE CYCLE COSTS
- ★ NAVY COST DRIVER STUDY

MANAGEMENT IMPROVEMENT ACTIONS

- ★ MANAGEMENT INFORMATION SYSTEM
- ★ PROJECT RANKING
- ★ PRODUCTIVITY ENHANCING CAPITAL INVESTMENT
- ★ PROGRAM MANAGERS

NAVY MANUFACTURING TECHNOLOGY PROGRAM



MTAG-81

★SAN DIEGO

AIR FORCE OVERVIEW

by

MR. JAMES J. MATTICE

Director of Manufacturing Technology
Air Force Wright Aeronautical Laboratories

PRECEDING PAGE BLANK-NOT FILMED

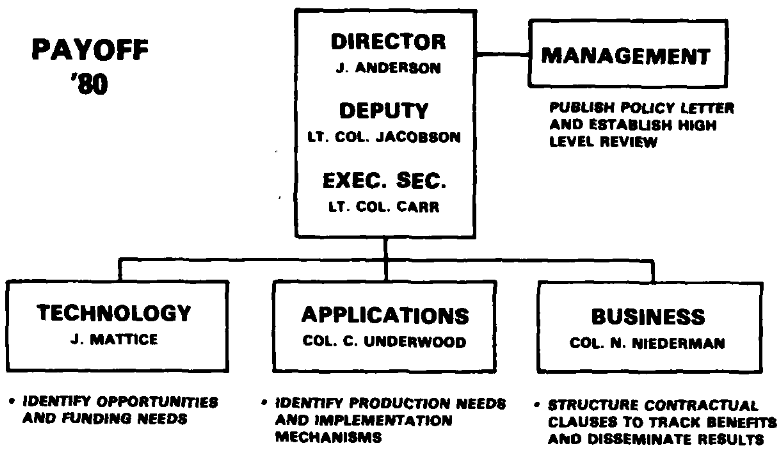
PRODUCTIVITY AND MATERIALS IMPACTS ON THE US

- PRODUCTIVITY GROWTH LOWEST OF INDUSTRIALIZED NATIONS
- ECONOMIC COMPETITIVENESS DECREASING
- DEPENDENCY ON FOREIGN RESOURCES GROWING
- INDUSTRIAL BASE ERODING
- NATIONAL SECURITY A CONCERN

BACKGROUND

• GEN SLAY — AFSC PAYOFF '80 TASKING	3 OCT 79
• DoD STATEMENT PRINCIPLES	14 MAR 80
• DEP. SEC. CLAYTOR PROGRESS REQUEST	30 MAY 80
• AFSC/AFLC/USAF SENIOR LEVEL REVIEW	31 JULY 80
• M/GEN. STANSBERRY REPORT TO DR. PERRY	3 OCT 80

MANUFACTURING TECHNOLOGY INVESTMENT STRATEGY (MTIS) ORGANIZATION



AFSC TASK FORCE CHARTER

PURPOSE

- DEVELOP AND IMPLEMENT STRATEGY TO ENHANCE PRODUCTIVITY AND RESPONSE OF THE INDUSTRIAL AND LOGISTICS BASE

OBJECTIVES

- COMMAND POLICY
- FUNDING STRATEGY
- NEEDS AND PAYOFF
- TECHNICAL AND BUSINESS STRATEGY
- IMPLEMENTATION
- BENEFITS TRACKING
- TECHNOLOGY TRANSFER
- SENIOR LEVEL REVIEW AND FEEDBACK

MAN TECH CHRONOLOGY

1970'S	— "SAGAMORE" TYPE COST STUDY DRIVEN THRUSTS
1974	— INITIAL AFLC INTERFACE
1976	— "INDIRECT" COST DRIVER RECOGNITION AND PROGRAM
1978-80	— BROADENING OF PRODUCT DIVISION INTERFACES
1979	— F-16 TECH. MOD.
1980'S	— REVISED OVERALL STRATEGY AND PROGRAM

DoD MAN TECH STATEMENT OF PRINCIPLES (14 MARCH 1980)

• Program Objectives	— Productivity — Responsiveness
• ROI Consciousness	— Specific Method and Use
• Program Planning	— Need Analysis — Tri-Service Integration — *Senior Level Review*
• Implementation and Benefits Tracking	— Information Availability — Technology Transfer Mechanism — Implementation Mechanism
• Evaluation	— Continuous Assessment Benefits Documentation
• Project Selection	— Technical Feasibility — DoD Requirement, Timing — Beyond Risk of Industry — Results Generic
• Program Management	— Strong Central Organization — Dedicated Funding — Multi-Service Joint Ventures — Tie To Acquisition Strategies

AFSC MAN TECH POLICY

PREMISE: Improved Manufacturing Productivity Will Reduce Acquisition And Ownership Costs

Man Tech Program Plays A Key Role

POLICY: Use ROI As Principal Criteria For Project Selection

Conduct Efforts Strongly Linked To Systems To Be Acquired

Conduct Efforts With Direct Application To ALC Needs

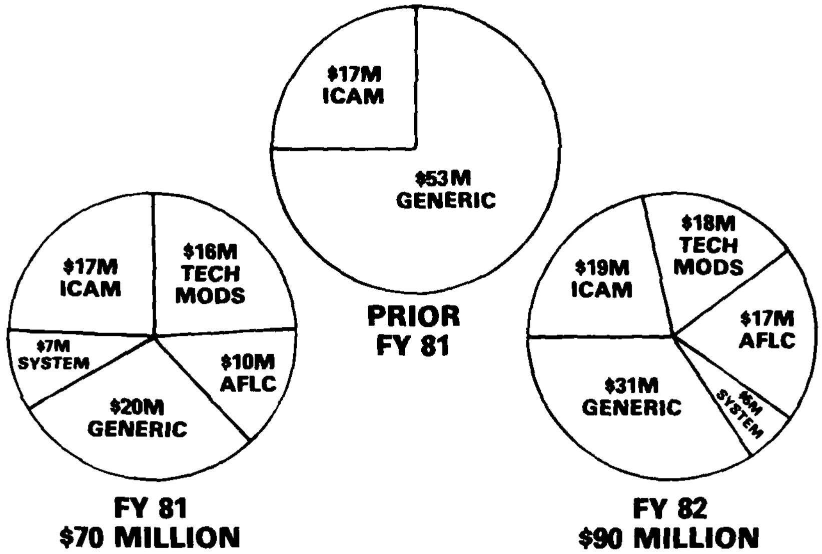
Ensure Early Implementation In Systems By:

- Use As Source Selection Factor
- Analyzing Major Cost Drivers, Bottlenecks
- Tie To Technology Modernization Initiatives

MANTECH PROGRAM

PAST	FUTURE
• MANY DISCRETE PROJECTS	• MAJOR THRUSTS
• WEAK DEMAND PULL	• SYSTEM & OPPORTUNITY DRIVEN
	• LINKED TO VANGUARD PLANNING PROCESS
• LIMITED IMPLEMENTATION	• STRONG IMPLEMENTATION & TRANSFER EMPHASIS
• INSUFFICIENT UNPROVEN BENEFITS	• DOCUMENTED BENEFITS
• LEVEL OF EFFORT PLANNING & FUNDING	• BUILT-UP PROGRAM BASED ON REQUIREMENTS
	• LEVER FOR INVESTMENT
	• EMPHASIZE READINESS

PAYOFF '80 PROGRAM CHANGES



FACTORS FOR TECH. MOD. SELECTION

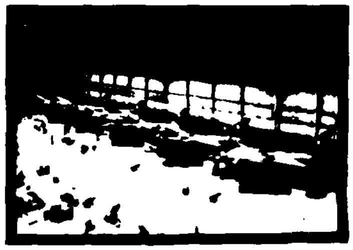
- PLANNED LEVEL OF CORPORATE INVESTMENT FOR MODERNIZATION
- AF/DoD PROJECTED BUSINESS BASE
- MILITARY/COMMERCIAL MIX
- OVERALL PROJECTED ROI
- CONTRACTOR VS. GOVERNMENT OWNED FACILITY
- COMPETITION

TECH MOD APPROACH

- SEPARATE CONTRACT
- MULTI-PHASE
  I. TOP DOWN ANALYSIS
  II. DESIGN OF MODULES
    — ENABLING TECHNOLOGIES
  III. IMPLEMENTATION
- BENEFITS TRACKING
- RESPONSIBILITIES
  - AF USERS — OVERALL PROGRAM MANAGEMENT
  - MANTECH — TECHNICAL MANAGEMENT

PROPOSED TECH. MOD. TYPES/CONTENT

TYPICAL "SYSTEM"	TYPICAL "FACTORY"
AMRAAM	BOEING WICHITA
• TERMINAL SEEKER	• CHEMICAL, FINISHING PROCESS CENTERS
• DATA PROCESSOR	• SHEET METAL FABRICATION
• AIRFRAME	• MACHINING CENTERS
• PROPULSION SYSTEM	• ADVANCED COMPOSITES
• RADOME	• ELECTRICAL, ELECTRONIC CELLS, CENTERS
• MFG. MANAGEMENT SYSTEM	• MFG. MANAGEMENT SYSTEM

MANUFACTURING TECHNOLOGY PROBLEM
Outdated Facilities At AFP-4;
No Mechanism For Major Modernization

APPROACH

- ICAM Systems Analysis Techniques
- F-16 SPO Leadership and Commitment
- Design and Implement Selected Work Centers

ACCOMPLISHMENTS & IMPACT

- $25M A.F./$100M Contractor Investment
- 3 Work Centers To Be Imple-mented—Machining, Sheet Metal, Electrical Bench
- Contractor Commitment
- Benefits Tracking Methodology
- $25M Savings Through FY 79/ $370M Savings Projected

ELEMENTS OF PRODUCTIVITY

PROGRAM STRATEGY

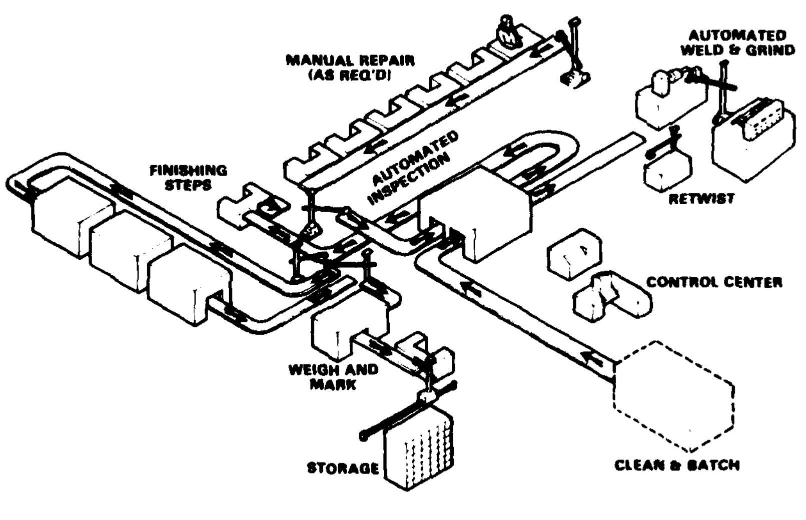
- TOTAL FACTORY APPROACH
- AIR FORCE FUNDS REQUIRED DEVELOPMENT
- INDUSTRY FUNDS REQUIRED EQUIPMENT, FACILITIES AND USES COMPLEMENTARY IR&D
- FITS WITH TECHNOLOGY MODERNIZATION PLANS
- VENDORS, PRIMES, AND SUBCONTRAC-TORS PARTICIPATE
- GENERIC AND SYSTEM SPECIFIC EMPHASIS
- SHORT AND LONG-TERM ROI

ALC MAINTENANCE
PLANNED INVESTMENTS FY 81-90

Distribution	Cost In $ Billions/Ten Years					
	ALC					
	OC	OO	SA	SM	WR	TOTAL
(A) ORGANIC RPR. AND MAINT. OPERATIONS	3.269	2.459	3.469	2.342	2.605	14.144
(B) SPARES AND MOD KITS*						33.234
(C) MODERNIZATION						
• FACILITIES**	.218	.276	.210	.154	.151	1.009
• EQUIPMENT						.600
TOTAL						48.987

*TEN YEAR BREAKDOWN DERIVED FROM ACTUAL SEVEN YEAR PROJECTION
**TEN YEAR BREAKDOWN DERIVED FROM ACTUAL FIVE YEAR PROJECTION

PRELIMINARY CONCEPT
AUTOMATED BLADE REPAIR CENTER



STRATEGIC MATERIALS
THE GEOGRAPHICAL PROBLEM

U.S. NET IMPORT RELIANCE OF SELECTED MINERALS AND METALS AS A PERCENTAGE OF CONSUMPTION IN 1978

Minerals and Metals	Net Import Reliance[1] as a Percentage of Apparent Consumption[2]	Major Foreign Sources (1974-1977)
Columbium	100	Brazil, Thailand, Canada
Manganese	97	Gabon, Brazil, Australia, South Africa
Tantalum	97	Thailand, Canada, Malaysia, Brazil
Cobalt	[illegible]	Zaire, Belgium-Luxembourg, Zambia, Finland
Bauxite and alumina	93	Jamaica, Australia, Surinam
Chromium	91	South Africa, USSR, Turkey, Southern Rhodesia
Platinum group metals	[illegible]	South Africa, USSR, United Kingdom
Tin	79	Malaysia, Bolivia, Thailand, Indonesia
Nickel	76	Canada, Norway, New Caledonia, Dominican Republic
Zinc	[illegible]	Canada, Mexico, Australia, Belgium-Luxemburg
Mercury	64	Algeria, Canada, Spain, Mexico, Yugoslavia
Cadmium	63	Canada, Australia, Belgium-Luxemburg, Mexico
Tungsten	[illegible]	Canada, Bolivia, Peru, Thailand
Gold	52	Canada, Switzerland, USSR
Silver	[illegible]	Canada, Mexico, Peru, United Kingdom
Selenium	43	Canada, Japan, Yugoslavia
Titanium (ilmenite)	42	Canada, Australia
Vanadium	[illegible]	South Africa, Chile, USSR
Iron ore	28	Canada, Venezuela, Brazil, Liberia
Antimony	23	South Africa, Bolivia, China, Mexico
Copper	20	Canada, Chile, Peru, Zambia
Aluminum	11	Canada
Lead	9	Canada, Mexico, Peru, Australia

1 Net import reliance = imports - exports + adjustments for government and industry stock exchanges
2 Apparent consumption = U.S. primary + secondary production + net import reliance
Source: Adapted from a chart published by the Bureau of Mines, U.S. Department of the Interior

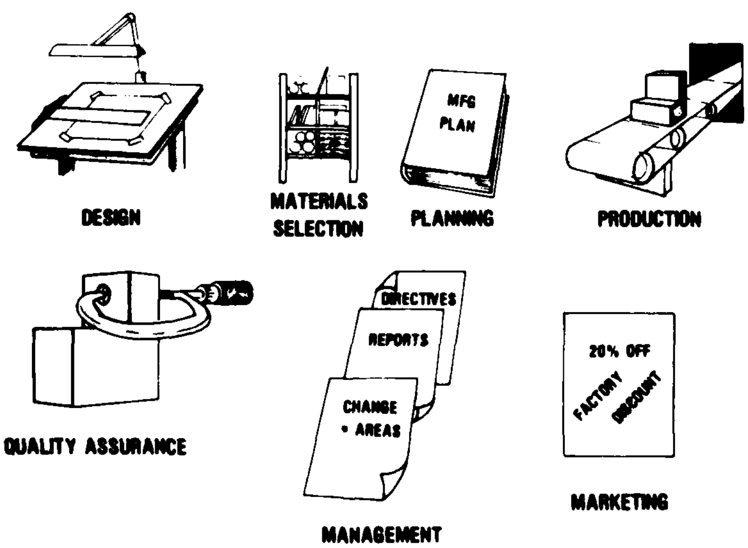
AVIONIC STRATEGIC/CRITICAL MATERIALS

- TANTALUM — CAPACITORS
- GOLD/SILVER/PALLADIUM/PLATINUM — CONTACTS/ COMPONENTS
- SILICON — INTEGRATED CIRCUITS
- COBALT — MAGNETS

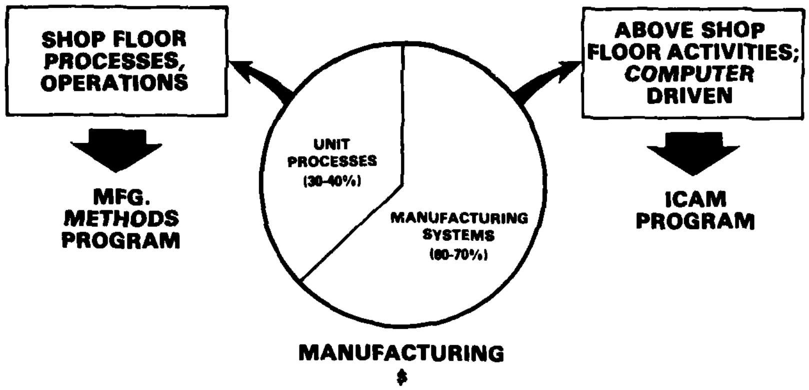
EXAMPLE: AMRAAM

RAYTHEON – 4 OZ. GOLD IN ELECTRONICS
TOTAL GOLD COST — 64 MILLION

MANUFACTURING



COST DISTRIBUTION FOR MANUFACTURED PRODUCTS



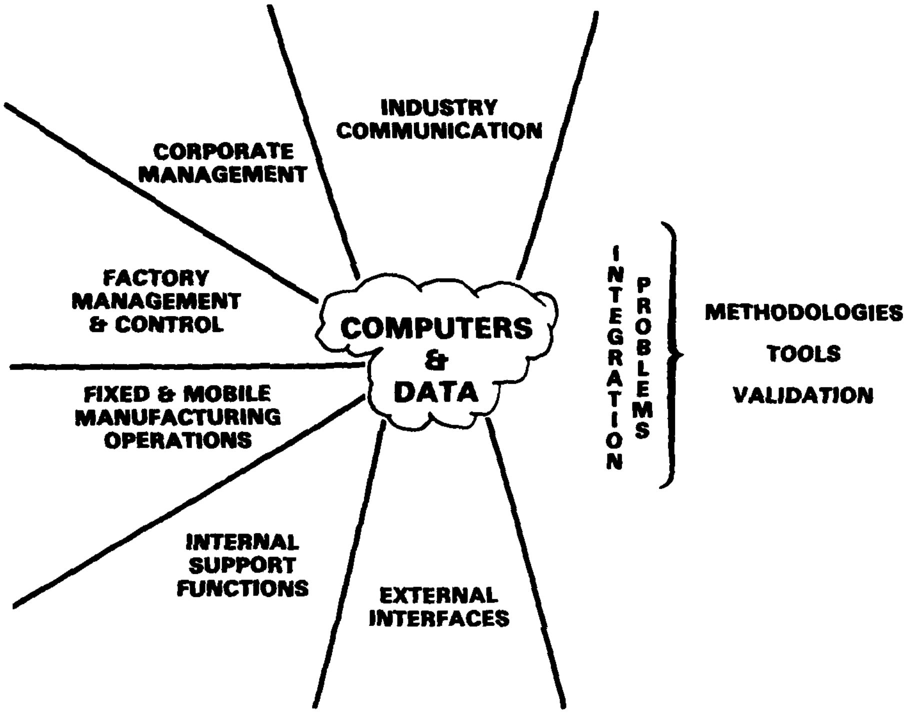
AIR FORCE ICAM PROGRAM

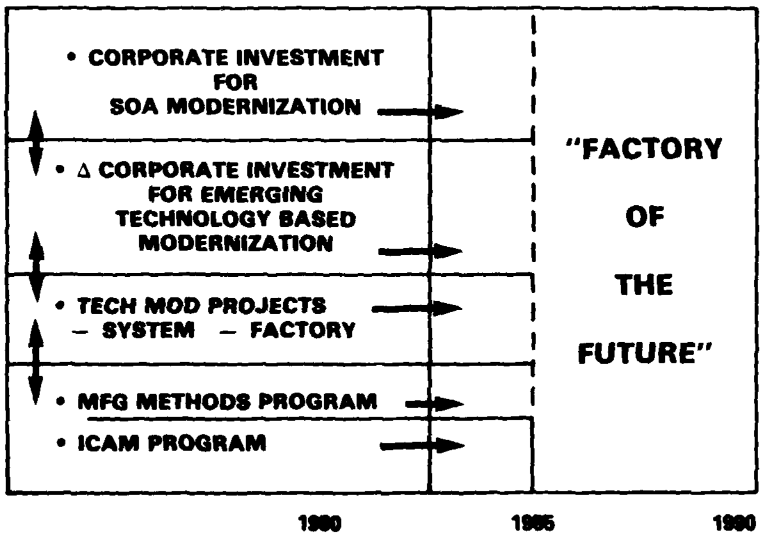
INTEGRATED COMPUTER-AIDED MANUFACTURING

PROBLEM NO SYSTEMATIC, INDUSTRY-*WIDE APPROACH* TO MANUFACTURING/PRODUCTIVITY COST DRIVER

APPROACH

1. BUILD ARCHITECTURE — BLUEPRINT
2. ESTABLISH INTEGRATING TOOLS
3. DEMONSTRATE ON SPECIFIC SHOP FLOOR COST CENTERS
4. IMPLEMENT ON AF PRODUCTION PROGRAMS
5. *TRANSITION ACROSS INDUSTRY; AUDIT BENEFITS*


INDUSTRY COMMUNICATION
CORPORATE MANAGEMENT
FACTORY MANAGEMENT & CONTROL
FIXED & MOBILE MANUFACTURING OPERATIONS
INTERNAL SUPPORT FUNCTIONS
EXTERNAL INTERFACES
COMPUTERS & DATA
INTEGRATION PROBLEMS
METHODOLOGIES
TOOLS
VALIDATION


• CORPORATE INVESTMENT FOR SOA MODERNIZATION
• Δ CORPORATE INVESTMENT FOR EMERGING TECHNOLOGY BASED MODERNIZATION
• TECH MOD PROJECTS
– SYSTEM – FACTORY
• MFG METHODS PROGRAM
• ICAM PROGRAM
"FACTORY OF THE FUTURE"
1980
1985
1990

CAPITAL INVESTMENT

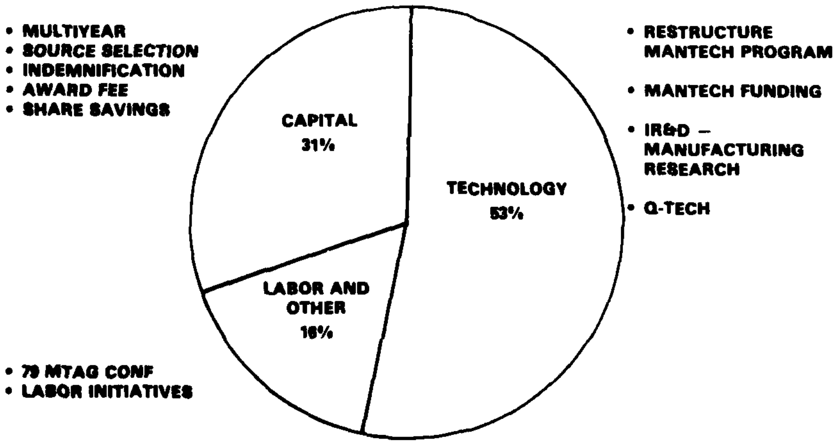
CONTRACTUAL INCENTIVES
- MULTI-YEAR CONTRACTING
- SOURCE SELECTION — EMPHASIS
- AWARD FEE
- ROI EMPHASIS
- INORDINATE RISK — INDEMNIFY
- PROFIT RETENTION — TIED TO IMPLEMENTATION

AIR FORCE OWNED FACILITIES (GOCO)

- AIR FORCE IS POOR LANDLORD
  - NO MODERNIZATION PROGRAM
- CRITICAL SECTOR ANALYSIS
  - DIVEST WHERE POSSIBLE
  - ENHANCE CAPTIVE INDUSTRIES
- MOTIVATE PRIVATE INVESTMENT

AFSC PRODUCTIVITY INITIATIVES

TECHNOLOGY MODERNIZATION



OVERALL USAF PRINCIPLES ASSESSMENT VS DoD

PRINCIPLE	CONDITION	ACTIVITY
PROGRAM OBJECTIVE	G	TIED TO ACQUISITION PROCESS/NEEDS
ROI CONSCIOUSNESS	Y	SYSTEMS PAYOFF/TECH MODS/DISCRETE PROJECTS
PROGRAM PLANNING	G	AFSC WIDE/AFLC-ALCs INPUTS
IMPLEMENTATION & TRANSFER	Y	TECH MODS/IMPLEMENTATION PLANS/LICENSING CLAUSES
EVALUATION	Y	AUDITABLE TECH MODS/DISCRETE PROJECTS FEEDBACK
PROJECT SELECTIVITY	G	STAFF/EXECUTIVE REVIEW/PRIORITIZATION
ASSESSMENT OF NEEDS	G	SYSTEMS DRIVEN/TECHNOLOGY THRUSTS
PROGRAM MANAGEMENT	G	CORPORATE APPROACH/APPROVAL

MANUFACTURING RESEARCH IN IR&D

- POLICY LETTER CLARIFYING DAR SECTION 15-205.35
- ENCOURAGE RESEARCH FOCUSED ON MANUFACTURING SYSTEMS, PROCESSES AND TECHNIQUES
- IR&D CEILING NEGOTIATIONS

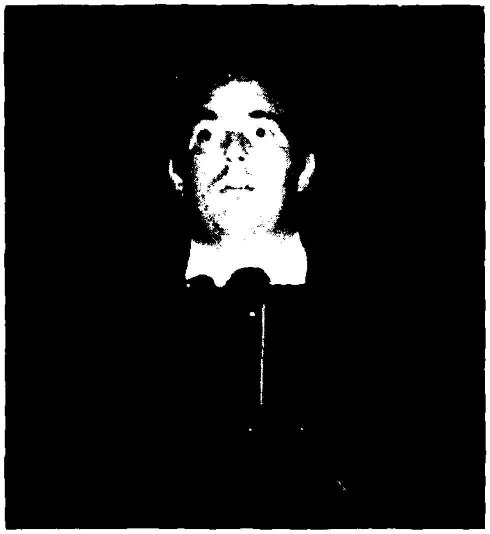
DARPA OVERVIEW

by

DR. MICHAEL J. BUCKLEY

Program Manager
Materials Science Division

Presentation not available for publication

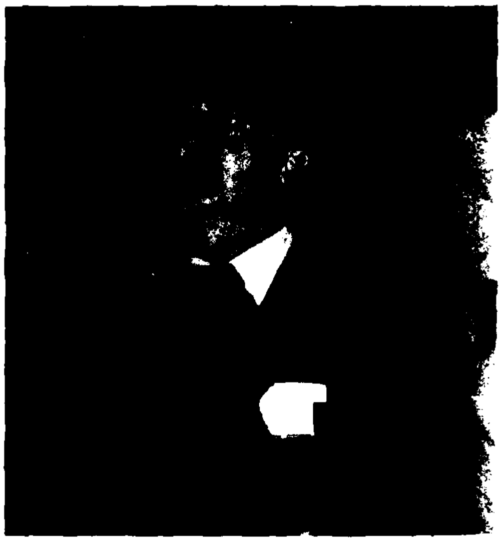


DEPARTMENT OF COMMERCE OVERVIEW

by

MR. CHARLES H. KIMZEY
Office of Cooperative Generic Technology

Presentation not available for publication



CAD/CAM SUBCOMMITTEE REPORT

by

MR. FRED MICHEL

Office of Manufacturing Technology

US ARMY MATERIEL DEVELOPMENT
AND READINESS COMMAND

ALEXANDRIA, VIRGINIA

MTAG 80

MANUFACTURING TECHNOLOGY ADVISORY GROUP

CAD/CAM SUBCOMMITTEE

1980

OVERVIEW

PRESENTED BY:
FREDERICK J. MICHEL
CHAIRMAN

20 OCTOBER 1980

Good afternoon, ladies and gentlemen!

Today I want to report to you on the activities of the CAD/CAM subcommittee during the past year. I am going to review the objectives of the committee as stated in the charter. Then I will report to you on the activities of the working groups, significant projects completed in 1980, some of the more significant projects planned for 1981 and 1982, the program for the three services for FY 81 and 82 and finally our perception of some major trends emerging in the 80s.

OUTLINE

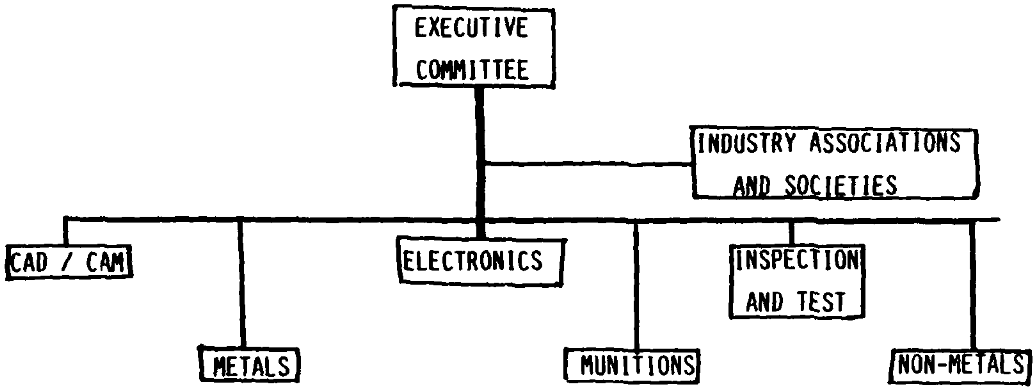
- INTRODUCTION
- OBJECTIVES
- WORKING GROUPS
- 1980 ACTIVITIES
- TECHNOLOGY REPORT
- FY 81 AND 82 PROGRAMS
- MAJOR TRENDS IN THE 80s

INTRODUCTION

Especially for those of you who have not worked with us in the past, I want to say that under the *DoD Manufacturing* Technology Advisory Group (MTAG) there are six subcommittees as shown on this vugraph. We are one of them.

DOD MANUFACTURING

TECHNOLOGY ADVISORY GROUP



CAD/CAM SUBCOMMITTEE

GOVERNMENT MEMBERSHIP

- DEPT. OF DEFENSE (DOD)
  - ARMY
  - NAVY
  - AIR FORCE
- DEPT. OF COMMERCE (DOC)
  - OFFICE OF COOPERATIVE GENERIC TECHNOLOGY
  - NATIONAL BUREAU OF STANDARDS
- DEFENSE LOGISTICS AGENCY
  - DEFENSE INDUSTRIAL PLANT EQUIPMENT CENTER (DIPEC)
- DEPT. OF ENERGY (DOE)
- NATIONAL AERONAUTICS AND SPACE ADMIN. (NASA)

MEMBERSHIP

The subcommittee is made up of government and industry associations and society members. The government organizations are the three services of the Department of Defense - the Army, Navy and Air Force, the Department of Commerce, the Defense Logistic Agency, the Department of Energy and NASA. The names of the members are shown on the left screen.

During the past year, a significant change took place. Our able and energetic chairman for the past four years, Dennis Wisnosky, resigned to take a job with International Harvester and I have been given the privilege of becoming the new chairman. I know that I have a tough act to follow.

Industry and the engineering community are represented by the organizations shown on this chart. The names of their representatives and the names of the companies for whom they work, are also shown.

CAD/CAM SUBCOMMITTEE

GOVERNMENT MEMBERSHIP

CHAIRMAN: FREDERICK J. MICHEL

ARMY	NAVY	AIR FORCE
RAY AMICONE	JOHN ANDERSON	TODD GARLAND
BOBBY AUSTIN	DENNIS BURNETT	GERRY HAYNES
LING CHIEN	BILL H[illegible]EN	GILBERT HAYS
RUSS HARRIS	RAY JONES	CHARLIE HOOPER
STAN HART	MICHAEL KEMLER	RICHARD KAMMERER
DOM IPPOLITO	RAYE PARROT	JOHN MC CRACKEN
VIC MONTUORI	JIM SAXMAN	DON SIMMONS
DAVE RUPPE	BOB SHADE	GERRY SHUMAKER
JIM SULLIVAN	RAY WELLS	
AL TAKEMOTO	GENE ZYBLIKEWYCZ	
DARRYL VEGH		

DEPT OF COMMERCE	DLA - DIPEC	DOE	NASA
CHUCK KIMZEY	GARLAND SMITH	JOHN BAKER	GEORGE SALLEY
BRAD SMITH			

INDUSTRY REPRESENTATION

- AIA — RAY NEAL, VOUGHT CORP.
- ADPA — TONY JUCAITIS, GOULD, INC.
- EIA — DALE HARTMAN, HUGHES AIRCRAFT CO.
- FIA — BOB CHIZMAR, ALCOA
- NCS — RON HUNT, N/C SOCIETY
- SME — DICK ABRAHAM, AUTO-PLACE, INC.

OBJECTIVES

The charter for the subcommittee contains three basic objectives:

1. To provide the technical analysis and working-level tri-service coordination of specific manufacturing technology projects related to the use of computers in all aspects of design engineering and manufacturing engineering.

2. To provide for coordination of these service programs with industry and other appropriate government agencies to promote widespread dissemination and application of new or improved manufacturing systems technology.

3. To make recommendations regarding: joint service efforts, elimination of duplication and establishment of manufacturing goals, policies and procedures.

OBJECTIVES

1 - PROVIDE TRI-SERVICE COORDINATION

2 - COORDINATE SERVICE PROGRAMS WITH INDUSTRY AND OTHER GOVERNMENT AGENCIES

3 - RECOMMEND:
- JOINT EFFORTS
- ELIMINATION OF DUPLICATION
- GOALS, POLICIES AND PROCEDURES

In 1980 we had eight AD HOC groups to address special problem areas and issues as shown on the vugraph to your right. The vugraph on the left shows the names of the people who participated in these activities. Due to the time limitations, I want to just high-light the most important ones.

The Group on CAD/CAM Dies and Molds evaluated the need for dedicated software for the design and manufacture of dies and molds.

The DIPEC Group assisted the Defense Industrial Plant Equipment Center with the N/C workshop for DoD components.

The ECAM Group reviewed the statement of work and provided guidance to the U. S. Army Missile Command in developing the concepts for the ECAM project.

The ICAM/Industry Day Group prepared an exhibit for the 30 September meeting and exhibit at St. Louis.

The Southfield Group reviewed the results of the Southfield meeting on which a detailed report will be presented at the Mini-Symposium on Wednesday.

CAD/CAM SUBCOMMITTEE

1980 WORKING GROUPS

- ANNUAL REPORT
- CAD/CAM DIES & MOLDS
- DIPEC
- ECAM
- ICAM/INDUSTRY DAY EXHIBIT
- MTAG 80
- MEMBERSHIP
- SOUTHFIELD

1980 WORKING GROUP MEMBERSHIP

- ANNUAL REPORT (G. HAYNES
  -(J. SULLIVAN
  (E. ZYBLIKEWYCZ
- CAD/CAM DIES & MOLDS (G. HAYNES
  -(J. SULLIVAN
  (E. ZYBLIKEWYCZ
- DIPEC (S. HART
  (G. SMITH
- ECAM (W. HOLDEN
  -(J. MC CRACKEN
  (F. J. MICHEL
- ICAM/INDUSTRY DAY EXHIBIT
  (L. CHIEN
  -(J. MC CRACKEN
  (F. J. MICHEL
- MTAG 80 (G. HAYNES
  -(J. SULLIVAN
  (E. ZYBLIKEWYCZ
- MEMBERSHIP (G. HAYNES
  -(J. SULLIVAN
  (E. ZYBLIKEWYCZ
- SOUTHFIELD (B. AUSTIN
  -(G. HAYNES
  (G. ZYBLIKEWYCZ

CAD/CAM SUBCOMMITTEE

1980 ACTIVITIES

30 APRIL - 1 MAY HARTFORD, CT (NCS ANNUAL CONFERENCE)	• REVIEW OF FY 81 PROJECTS • ASSIGN AD HOC GROUP WORK • MEETING WITH INDUSTRY
14 AUGUST ST. LOUIS, MO	• REVIEW WORK OF AD HOC GROUPS • PLAN FOR MTAG 80 • PREPARE ANNUAL REPORT • PLAN BOOTH FOR ICAM/INDUSTRY DAY
21 - 24 OCTOBER BAL HARBOR, FL (MTAG '80)	• PRESENT ANNUAL REPORT • CONDUCT MINI-SYMPOSIUM • PLAN TECHNOLOGY TRANSFER • ORIENTATION ON ARCHITECTURE
4 DECEMBER WASHINGTON, D. C.	• PLAN 1981 PROGRAM

During 1980 the subcommittee will have had four meetings. The first one took place at Hartford, CT in conjunction with the annual conference of the N/C society. At this meeting we reviewed the projects proposed by the three services for FY 81 and made assignments to the AD HOC Groups. Yours truly was installed as the new chairman. At the next meeting, which took place in St. Louis, we made plans for an exhibit for the ICAM/Industry Day sponsored by the Air Force, reviewed the work of the AD HOC Groups, made our plans for MTAG 80, and prepared the annual report.

At the ICAM/Industry Day in St. Louis we presented a plaque to Dennis Wisnosky in recognition of the work he has performed as our chairman for the past four years.

On Wednesday we are holding a mini-symposium at which our annual report will be made available to you. On Thursday and Friday, we are going to plan a technology transfer program and will receive an orientation of manufacturing architecture. In December we are going to plan our 1980 program.

CAD/CAM SUBCOMMITTEE

THREE SIGNIFICANT PROJECTS COMPLETED IN 1980

SERVICE	PROJECT	POINT OF CONTACT
ARMY	N/C LATHE LANGUAGE EVALUATION	DAVE RUPPE, CORADCOM 201 - 544 - 4251
NAVY	COMPUTER N/C CONTROLLED SHIPS FRAME BENDER	RICHARD A. GAMBLE, NOSC 714 - 225 - 6457
AIR FORCE	INTEGRATED MANUFACTURING CONTROL - MATERIAL MANAGEMENT	CAPT. JOHN MC CRACKEN, AFML 513 - 255 - 2562

Now I want to speak to you about some significant projects recently completed. Some on-going projects supported by funds provided by all three services and the service plans for FY 81 and FY 82.

In FY 80, the three services completed 27 CAD/CAM projects representing an investment of $11 million. An example from each of the three services will follow.

1. The objective of the Army project was to conduct an evaluation of 15 N/C lathe programming systems and characterize them qualitatively and quantitatively to help our arsenal shops pick the most cost effective one.

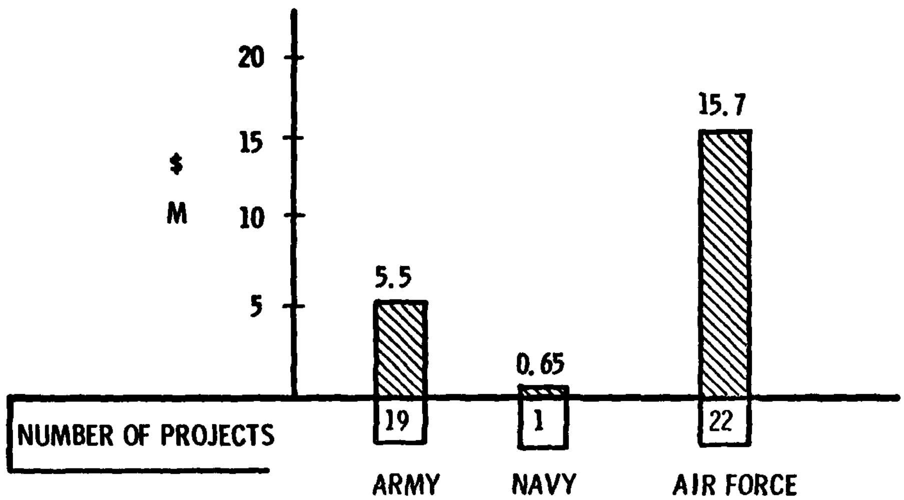
   The results are shown on the vugraph appearing on the left screen.

2. The Navy project demonstrates the practicality of applying CAM concepts to the forming of frames used in the construction of ships. The original work was done at Case Western in Cleveland sponsored by the National Science Foundation, and a working machine was demonstrated recently.

3. The result of one of the Air Force projects is a detailed design of the application software for a new minicomputer based real-time control system which will provide information to the supervisor for improved decision making.

CAD/CAM SUBCOMMITTEE

FY 80 CAM PROGRAM



PROJECTS STARTED IN 1980

In FY 80 the three services have 42 CAD/CAM projects valued at $21.85 million of which you will find a complete list in our annual report.

The three most significant ones are highlighted here:

1. The Army's ECAM or Electronic Computer Aided Manufacturing Project which has two basic objectives: (1) To define the architecture of the design and manufacture of military electronic equipment and (2) to identify those projects which should be undertaken to fill technology gaps in a computer integrated program.

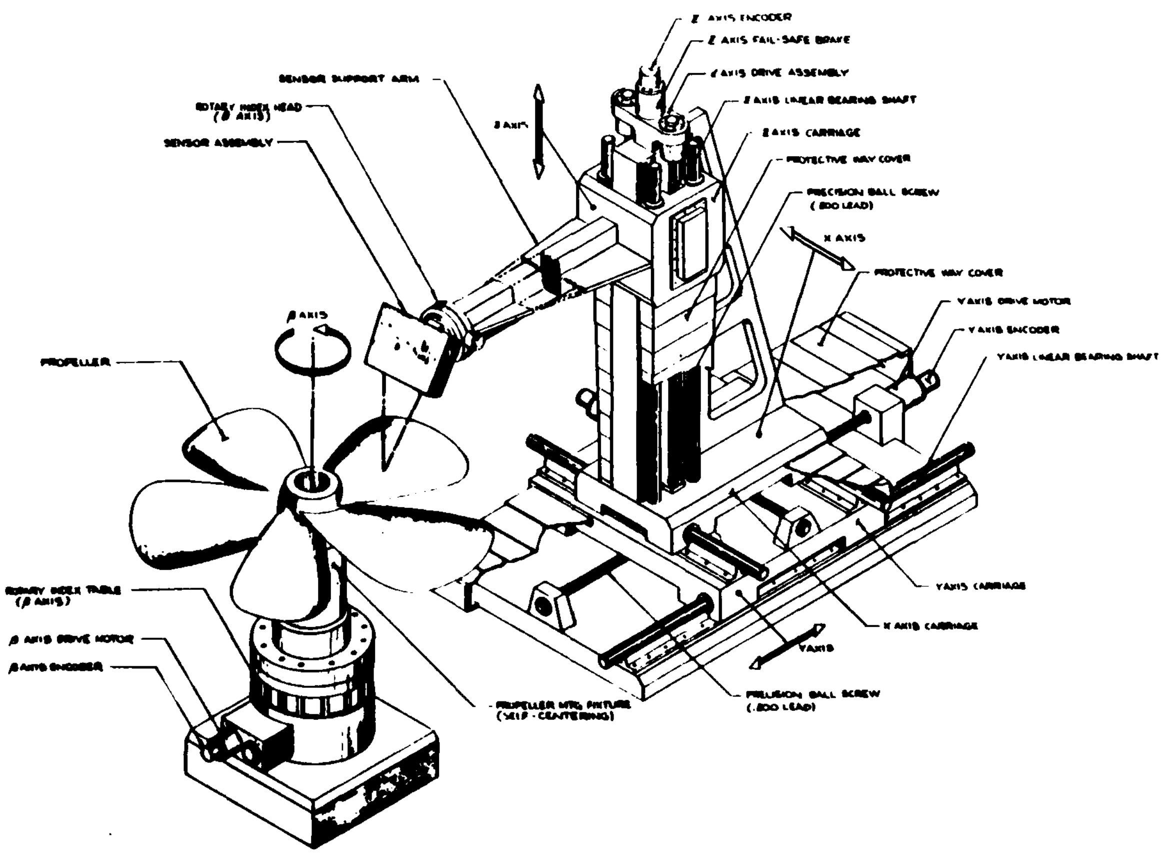
2. The objective of the Navy project is to demonstrate on the manufacturing floor a laser scan, digitally formated, in-process inspection technique compatible with CAD/CAM systems.

3. The Air Force project addresses the integration of the major planning functions defined by the architecture of manufacturing. Those functions are: plan for manufacturing (facilitization); process planning (how to produce) and manufacturing planning (when to produce).

CAD/CAM SUBCOMMITTEE

THREE SIGNIFICANT PROJECTS STARTED IN 1980

SERVICE	PROJECT	POINT OF CONTACT
ARMY	ECAM	GORDON LITTLE, MICOM 205 - 876 - 3848
NAVY	AUTOMATED PROPELLER OPTICAL MEASUREMENT SYSTEM	MICHAEL KEMLER, USN 215 - 755 - 3582
AIR FORCE	INTEGRATED PLANNING SYSTEM	DAVID JEPSON, AFML 513 - 255 - 2562



CAD/CAM SUBCOMMITTEE

THREE SIGNIFICANT TRI-SERVICE SUPPORTED PROJECTS

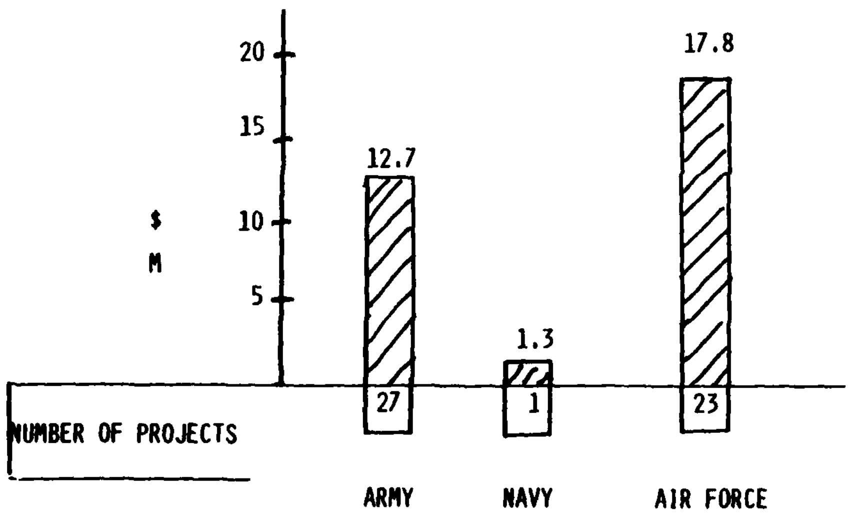
• ELECTRONIC COMPUTER AIDED MANUFACTURING (ECAM)	GORDON LITTLE, MICOM 205 - 876 - 3848
• INITIAL GRAPHICS EXCHANGE SPECIFICATION (IGES)	BRAD SMITH, NBS 301 - 921 - 2381
• ELECTRONIC GROUP TECHNOLOGY (EGT)	STAN HART, ARRADCOM 201 - 328 - 3721

Three examples of currently multi-service supported projects are shown here. The first one I have described a few minutes ago. The IGES project was initiated to establish standards for inter-active graphics. It has recently been submitted to the American National Standards Institue (ANSI) and has an excellent chance of very shortly becoming a national standard. This project is an example of an outstanding cooperative effort of industry and government. The idea of standard was proposed by industry at our Southfield Meeting in September 1979. One year later a standard is in the hands of the members of the appropriate ANSI committee to be voted on.

The third project is undertaken to identify the concepts which should be used to structure the group technology coding system for parts used in electronic equipment.

CAD/CAM SUBCOMMITTEE

FY 81 CAM PROGRAM



The FY 81 CAM Program for the three services provides for an expenditure of $31.8M for a total of 51 projects. A list of the projects and the points of contact can be found in our annual report.

The three most significant ones, by service are:

1. For the Army: A project to be implemented at Watervliet Arsenal based on the concept of distributive DNC.
2. For the Navy: A demonstration of automated fabrication processes for microwave stripline circuit boards.
3. For the Air Force: An intensive study of the assembly of discrete aircraft parts and the formulation of a conceptual design for an integrated assembly center.

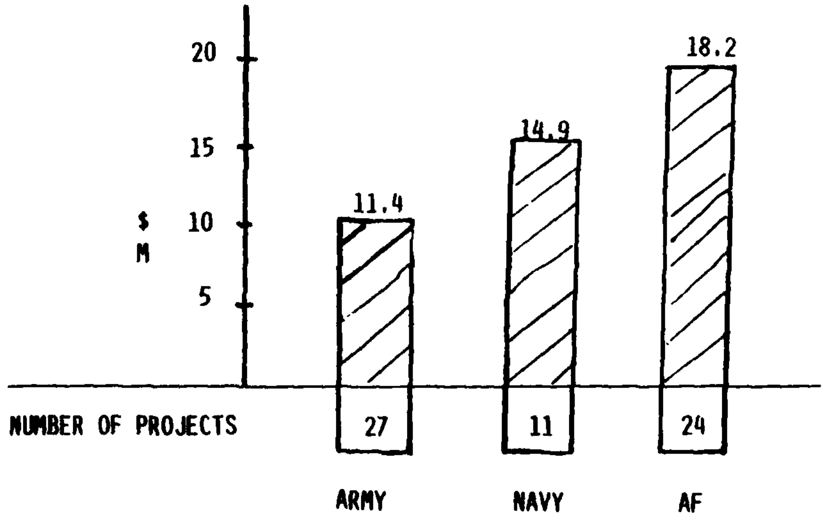
CAD/CAM SUBCOMMITTEE

THREE SIGNIFICANT PROJECTS TO BE STARTED IN 1981

SERVICE	PROJECT	POINT OF CONTACT
ARMY	COMPUTER INTEGRATED MFG. - DISTRIBUTIVE DNC	DOM IPPOLITO, WATERVLIET 518 - 266 - 5719
NAVY	AUTOMATED MICROWAVE CIRCUIT BOARD FAB.	STEVE LINDER, NASC 202 - 692 - 7640
AIR FORCE	ICAM ASSEMBLY REQUIREMENTS AND DESIGN	CAPT. JOHN MC CRACKEN 513 - 255 - 2562

CAD/CAM SUBCOMMITTEE

FY 82 CAM PROGRAM



In FY 82 the services expect to spend $44.5M on 62 CAM projects. This represents a growth of almost 50% over FY 81. Three of the most significant projects to be started in FY 82 are shown on the vugraph to the left.

The Army — Plans to have a project to develop an automated, computer directed, soldering system for sealing of packages containing micro circuits.

The Navy — Expects to support a project to establish a full spectrum of integrated industrial automation technology with the U.S. shipbuilding industry.

The Air Force — Plans to undertake a project to refine and enhance requirements and establish the design of a Data Automation Processor (DAPRO) as the mechanism for processing transactions in an on-line real time environment.

CAD/CAM SUBCOMMITTEE

THREE SIGNIFICANT PROJECTS TO BE STARTED IN 1982

SERVICE	PROJECT	POINT OF CONTACT
ARMY	AUTOMATIC SEALING OF HYBRIDS	ROBERT WOOTER, MICOM 205 - 876 - 8487
NAVY	SHIPBUILDING TECHNOLOGY PROGRAM	WILLIAM F. HOLDEN, NAVMAT 202 - 692 - 1411
AIR FORCE	ICAM DATA AUTOMATION PROCESSOR (DAPRO) SYSTEM DEFINITION	FRANK BORASZ, AFML 513 - 255 - 2562

MINI-SYMPOSIUM

On Wednesday, beginning at 8:30 am, we are going to hold a mini-symposium consisting of a 20-minute movie and eleven technical papers. The titles and the names of the presenters are shown on the screen. The first paper covers the Southfield Meeting. The other papers represent a cross-section of CAM projects sponsored by the three services dealing with standards, fabrication methods, factory modernization, automated inspection and automated management systems. Also, we will have our annual report available. I hope that you will be able to attend.

CAD/CAM SUBCOMMITTEE

MTAG 80 MINISYMPOSIUM

TIME: 2? OCTOBER 1980 8:30 A.M.

PLACE: EASTWOOD/WESTWOOD #1

PROGRAM:	• SOUTHFIELD REPORT - THE MTAG CAD/CAM SUB-COMMITTEE RESPONSE TO INDUSTRY RECOMMENDATIONS	MAJ GERALD HAYNES AFML
	• INITIAL GRAPHIC EXCHANGE SPECIFICATION (IGES)	MR. BRADFORD M. SMITH NBS
	• BLISK & IMPELLER AIRFOIL MANUFACTURING SYSTEM	MR. WILLIAM D. ROUSE GENERAL ELECTRIC CO.
	• TECHNOLOGY MODERNIZATION - ARE THE RESULTS WORTH THE PROBLEM?	DR. DANNY L. REED GENERAL DYNAMICS

• AUTOMATED PROPELLER OPTICAL MEASUREMENT SYSTEM	MR MICHAEL KEMLER USN
• FLEXIBLE MACHINING SYSTEM TECHNOLOGY	MR. ALFRED G. KIRCHNER GENERAL ELECTRIC CO.
• SHEET METAL CENTER CONCEPT DESIGN	MR. ALAN T. TAYLOR BOEING COMMERCIAL AIRPLANE CO.
• ROBOTIC SYSTEM FOR AEROSPACE BATCH MANUFACTURING - TASK B	DR. MARGARET EASTWOOD MC DONNEL-DOUGLAS AUTOMATION CO.
• COMPUTER - AIDED DESIGN OF THE POWER FORGING PROCESS	DR. HOWARD A. KUHN U OF PITTSBURGH
• AUTOMATIC CONTROL OF PLATING	MR. R. T. APODACA GENERAL DYNAMICS
• ICAM INTEGRATED MFG CONTROL - MATERIAL MANAGEMENT SYSTEM	MR. AL RUBENSTEIN GENERAL ELECTRIC CO.

CAD/CAM SUBCOMMITTEE

MAJOR TRENDS IN THE 80s

- INVESTMENT STATEGY
- DISTRIBUTIVE SYSTEMS
- THE SYSTEM APPROACH - CAD/CAM/CAT
- COMMON DATA BASE

MAJOR TRENDS IN THE 80s

Over the next few years, we see several trends emerging. For one, the system or top-down approach in re-evaluating existing plants and designing new manufacturing facilities will be applied more widely. This approach will capture improved productivity arising from the synergism which results from the combining of related manufacturing operations. Our engineering schools are starting to train manufacturing engineers with the skills necessary for implementing this concept. Management is beginning to recognize the potential benefits that can be derived from this approach.

One of the most significant developments making tne systems approach possible was the advent of the minicomputer and the microprocesssor through the truly remarkable cost reductions which these devices have experienced. To quote the June 30 issue of Business Week: "Microprocessors will have a bigger impact on life style than the change brought about by television." These developments and some of the technology developments about which you have heard this afternoon, will indeed make CAD/CAM/CAT become a reality.

The Third Element - In addition to the systems approach and low-cost computers is the development of the data base concept. The capturing of the design and manufacturing information from prior projects will create a reservoir of information for the designer and planner that will make their work infinitely more effective. Through the corporate memory thus created the learning curve of new employees will be improved immeasurably.

The technological innovations no doubt will also have a profound effect on the organizational structure of the future business unit. Much paper work will be eliminated and much more information will become available at all levels of the organization on a real time basis. The management structure and employee functions will change considerably.

We foresee exciting opportunities and expect to provide seed money for the projects having the greater risks with the expectation that industry will reap the benefits sooner, that the cost of our weapons will be reduced and that the productivity of our industrial base will be improved. As the editor of the June 12, 1980 issue of Machine Design stated: "An engineer can use a computer to design a component, analyze its stresses, and check its mechanical action. Production people can use the same computer to transform the design into hardware through NC machining or other automated processes. Now the two technologies - CAD and CAM - are merging, allowing a single individual to conceive of an object and then set in motion the computer - controlled processes that will produce it.

SUMMARY

- OBJECTIVES
- WORKING GROUPS
- 1980 ACTIVITIES
- TECHNOLOGY REPORT
- FY 81 AND 82 PROGRAMS
- MAJOR TRENDS IN THE 80s

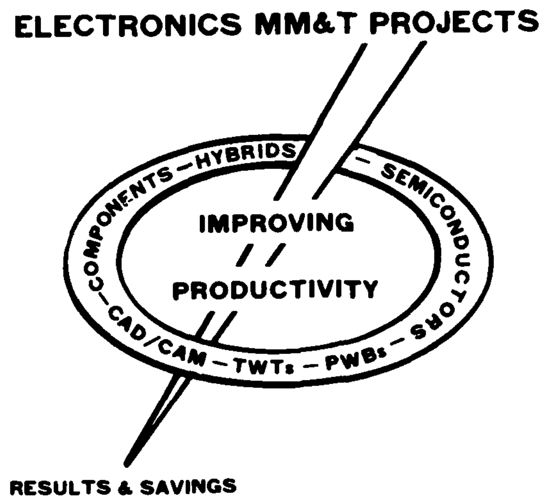
In summary, we've had a very active year. I have told you about our objectives, the activities of our AD HOC Groups, what was accomplished and what was started in FY 80, what we expect to do in FY 81 and what we are planning for FY 82. I spoke about some of our jointly funded projects and told you about the mini-symposium which we hope will encourage the transfer of technology. In conclusion, I tried to give you an assessment of what we foresee the future of CAD/CAM to be and to bring.

Thank you.

ELECTRONICS SUBCOMMITTEE OVERVIEW

by

MR. CHARLES McBURNEY



ELECTRONICS SUBCOMMITTEE REPORT

TO THE

MANUFACTURING TECHNOLOGY

ADVISORY GROUP

MTAG 80

Ladies and Gentlemen. Each succeeding year that I am called upon to make this briefing, I realize more and more what a privilege it is to present it to you. This report of the electronics and electro-optics subcommittee activities and results is the twelfth annual briefing to the manufacturing technology advisory group.

As chairman, I will provide an overview of electronics and electro-optics programs for FY82 and a short summary of accomplishments over recent years. Then I will introduce from the audience several of the woking group chairmen, and provide a brief review of their activities. At the mini-symposium on Wednesday, industry and Government representatives will have an opportunity to meet these working group chairmen and the members of the subcommittee.

INTRODUCTION

- SIZE OF THE FY82 PROPOSED PROGRAM
- TECHNICAL AREAS
- PROJECT COORDINATION MEETINGS
- REVIEW PROCEDURES
- WORKING GROUP CHAIRMEN INFORMATION
- AREAS OF TRI-SERVICE INTEREST
- AREAS OF MUTUAL INTEREST
- JOINT EFFORTS
- TECHNOLOGY OPPORTUNITIES

DURING THIS BRIEFING I WILL ILLUSTRATE THE SIZE OF THE SERVICE'S FY82 ELECTRONICS AND ELECTRO-OPTICS PROGRAMS IN DOLLARS AND NUMBER OF PROJECTS BY TECHNICAL AREA, AND NOTE THE TYPES OF PROJECTS INCLUDED IN EACH AREA.

THEN I WILL DISCUSS THE VARIOUS PROJECT COORDINATION MEETINGS AND THE REVIEW PROCEDURES USED THROUGHOUT THE YEAR TO COORDINATE THESE PROJECTS IN THEIR SIX TECHNICAL AREAS. I'LL TELL YOU HOW WE MET WITH THE MAJOR TECHNICAL SOCIETIES AND WITH THE ELECTRONICS INDUSTRY ASSOCIATION TO DISCUSS DOD PROPOSALS IN RELATIONSHIP WITH ON-GOING WORK AT LEADING FIRMS.

NEXT, YOU WILL HEAR INFORMATION SUPPLIED BY THE WORKING GROUP CHAIRMEN ON THEIR MAJOR THRUSTS. THEN YOU'LL HEAR ABOUT WORK HAVING TRI-SERVICE INTEREST, TWO-SERVICE INTEREST, CURRENT JOINT EFFORTS, AND SEVERAL MAJOR ACCOMPLISHMENTS IN TECHNOLOGY TRANSFER.

IN CLOSING, I'LL MENTION OPPORTUNITY FOR ADDITIONAL WORK. THIS BRIEFING IS DESIGNED TO GIVE YOU A FULL OVERVIEW OF THE TRI-SERVICE PROGRAM IN ELECTRONICS.

SIZE OF THE ELECTRONICS, ELECTRO-OPTICS PROGRAM

- **30 AIR FORCE PROPOSALS COSTING $17.7 MILLION**
- **14 NAVY PROPOSALS COSTING $10.1 MILLION**
- **39 ARMY PROPOSALS COSTING $24.3 MILLION**

83 PROPOSALS FOR $52.1 MILLION

HERE IS AN ILLUSTRATION OF THE SIZE OF THE ELECTRONICS PROGRAM.

AIR FORCE HAS 30 PROPOSALS WORTH 17.7 MILLION DOLLARS, A 2.5 MILLION INCREASE OVER LAST YEAR.

NAVY HAS 14 PROPOSALS WORTH 10.1 MILLION DOLLARS, A ONE-THIRD REDUCTION FROM LAST YEAR.

ARMY, WITH ITS THIRTEEN SUBCOMMANDS, BUDGETED FOR 39 PROJECTS AT 24.3 MILLION DOLLARS, A ONE-FOURTH REDUCTION FROM LAST YEAR.

THUS, THE TOTAL PROGRAM CONSISTS OF 83 PROJECTS WORTH 52.1 MILLION DOLLARS. THESE ARE THE PROPOSALS THAT SURVIVED TWO LEVELS OF BUDGET REVIEW. THE THREE DEPARTMENTS SCREENED OVER 100 PROPOSALS WORTH ABOUT 60 MILLION DOLLARS PRIOR TO ACCEPTANCE OF THSE PROJECTS FOR BUDGET APPROVAL.

TECHNICAL AREAS

- ELECTRO-OPTICS/OPTICS
- MICROWAVE DEVICES/TRAVELING WAVE TUBES
- SEMICONDUCTORS/INTEGRATED CIRCUITS
- COMPONENTS/PACKAGING
- ELECTRONICS CAD/CAM
- HYBRID CIRCUITS

TO SIMPLIFY THE TASK OF COORDINATING OVER ONE HUNDRED PROJECTS, THEY WERE DIVIDED INTO THE TECHNICAL AREAS SHOWN HERE: ELECTRO-OPTICS AND OPTICS, MICROWAVE DEVICES, SEMICONDUCTORS AND INTEGRATED CIRCUITS, COMPONENTS AND PACKAGING, ELECTRONICS CAD/CAM, AND HYBRID CIRCUITS. EACH PROJECT WAS ASSIGNED TO ONE OR MORE OF THESE AREAS BY THE COMMITTEE CHAIRMAN.

NOW, LET'S DELINIATE THESE AREAS BY NOTING THE MAJOR ITEMS INCLUDED IN EACH.

TECHNICAL AREAS IN ELECTRONICS

AREA	TASKS
ELECTRO-OPTICS AND OPTICS	FIBER OPTICS SOURCES, CABLES, DETECTORS AND CONNECTORS; NIGHT VISION COMPONENTS; GLASS AND PLASTIC OPTICS; DISPLAYS; LASERS.
MICROWAVE DEVICES AND TRAVELING WAVE TUBES	MILLIMETER WAVE DEVICES; GALLIUM ARSENIDE IMPATT DIODES; MICROWAVE INTEGRATED CIRCUITS; TRAVELING WAVE TUBES AND AMPLIFIERS; MAGNETRONS.
SEMICONDUCTORS AND INTEGRATED CIRCUITS	BI-POLAR DEVICES, HIGH FREQUENCY DIODES AND TRANSISTORS; SOLAR CELLS; POWER DEVICES; HIGH REL. TECHNIQUES; LARGE SCALE INTEGRATED CIRCUITS; CCDS; ROMS; CMOS; CMOS ON SOS; VLSI. MICROWAVE ICS.

MAY 80

ELECTRO-OPTICS INCLUDES DETECTORS AND SIGNAL PROCESSORS, NIGHT VISION COMPONENTS, SEEKERS, DISPLAYS, LASERS, AND TESTERS FOR OPTIC SYSTEMS.

MICROWAVE DEVICES INCLUDE MANY TYPES OF MILLIMETER WAVE COMPONENTS, IMPATT DIODES, PIN DIODES, GUNN TRANSISTORS, AND POWER TRANSISTORS. ALSO, MICROWAVE CIRCUITS AND ULTRA HIGH FREQUENCY COMPONENTS. TUBES INCLUDE TWT AMPLIFIERS, CROSSFIELD AMPLIFIERS, AND MAGNETRONS.

SEMICONDUCTORS CONSIST OF HIGH FREQUENCY DIODES AND TRANSISTORS, HIGH POWER DEVICES, INTEGRATED CIRCUITS, READ ONLY MEMORIES, METAL OXIDE SEMICONDUCTORS, AND VERY LARGE SCALE INTEGRATED CIRCUITS.

TECHNICAL AREAS IN ELECTRONICS

AREA	TASKS
COMPONENTS AND PACKAGING	CRYSTALS; SENSORS; PRINTED CIRCUIT BOARDS; STRIPLINE; CHIP CARRIERS; POWER SOURCES; BATTERIES.
ELECTRONICS CAD/CAM	SYSTEMS FOR DESIGNING AND MANUFACTURING PRINTED CIRCUITS, HYBRID CIRCUITS, AND INTEGRATED CIRCUITS.
HYBRID CIRCUITS	LARGE SCALE HYBRIDS; INKS AND SUBSTRATES; PACKAGES; HEAT PIPES; COMPUTERIZED TESTERS.

COMPONENTS INCLUDE CRYSTALS AND OSCILLATORS, SENSORS, CIRCUIT BOARDS, STRIPLINE, CHIP CARRIERS, BATTERIES, AND POWER SUPPLIES.

CAD/CAM INCLUDES SYSTEMS FOR MANUFACTURING PRINTED CIRCUITS, HYBRID MICROCIRCUITS, AND INTEGRATED CIRCUITS.

HYBRID CIRCUITS CONSIST OF THICK AND THIN FILM CIRCUITS, LARGE SCALE HYBRIDS, SUBSTRATES, PACKAGES, HEAT PIPES, AND TESTERS.

NOW LET'S LOOK AT THE RELATIVE IMPORTANCE OF THESE AREAS.

TECHNICAL AREAS IN ELECTRONICS

AREA	NO OF PROJECTS
ELECTRO-OPTICS	26
MICROWAVE DEVICES	21
COMPONENTS AND PACKAGING	21
SEMICONDUCTORS AND ICS	16
ELECTRONICS CAD/CAM	16
HYBRID CIRCUITS	9
TOTAL	109

Electro-optics and optics comprise the largest number of projects, 26, and microwave devices and traveling wave tubes are addressed in 21 projects.

Components and packaging - including universally used printed circuits - are also addressed in 21.

Semiconductors and integrated ciruits will be worked on in 16 projects.

Electronics computer aided design and manufacture will also be studied in 16 projects.

The smallest area is hybrid circuit with 9 projects.

TECHNICAL AREAS IN ELECTRONICS

AREA	NO OF PROJECTS	COST IN MILLIONS
COMPONENTS AND PACKAGING	21	$18.6
MICROWAVE DEVICES	21	14.9
SEMICONDUCTORS AND ICS	16	12.2
ELECTRONICS CAD/CAM	16	11.4
ELECTRO-OPTICS	26	11.0
HYBRID CIRCUITS	9	6.2
TOTAL	109	$74.3

SHOWN HERE ARE THE FUNDING LEVELS BY TECHNICAL AREA; NOTE THAT COMPONENTS AND PACKAGING HAS THE HIGHEST FUNDING, CHIEFLY BECAUSE OF AIR FORCE EFFORT ON ADVANCED TECHNOLOGY FOR CIRCUIT BOARDS.

THE HEAVY EMPHASIS IN MICROWAVE INTEGRATED CIRCUITS DROVE UP THE MICROWAVE DEVICES AREA.

THE NEXT THREE AREAS SHOW ALMOST EQUAL PROJECTIONS, WHILE HYBRID CIRCUITS ARE PROJECTED AT HALF THAT AMOUNT.

FY82 BUDGETED ELECTRONICS AND ELECTRO-OPTICS PROJECTS

NUMBER OF PROJECTS

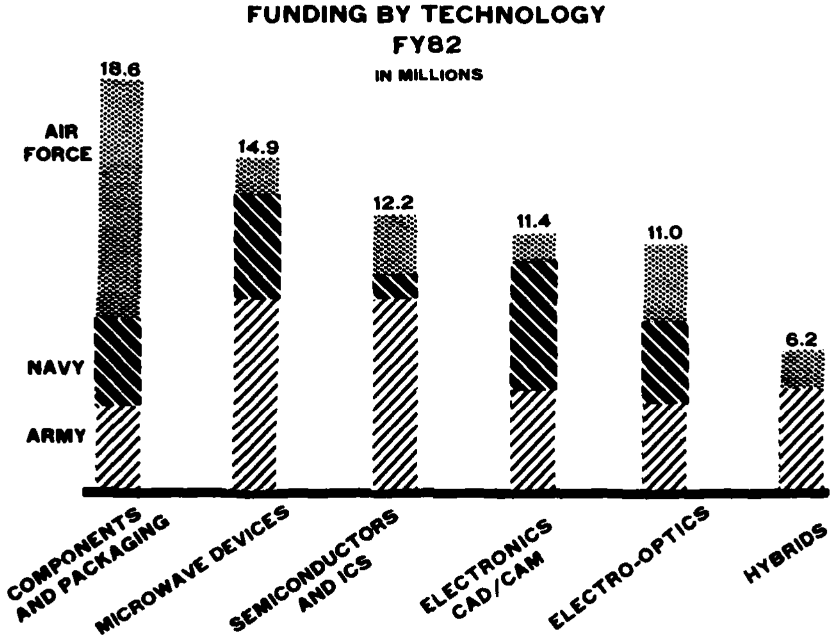
TECHNICAL AREA *	ARMY	NAVY	AIR FORCE	TOTAL
ELECTRO-OPTICS	15	7	4	26
MICROWAVE DEVICES	9	9	3	21
COMPONENTS/PACKAGING	8	3	10	21
SEMICONDUCTORS/ICS	10	1	5	16
ELECTRONICS CAD/CAM	9	5	2	16
HYBRIDS	7	0	2	9
TOTAL	58	25	26	109

* THERE IS SOME OVERLAP BETWEEN TECHNICAL AREAS.

Here is shown a breakdown of projects by Service.

Electro-optics includes a large number of Army and Navy projects, as do microwave devices, electronics CAD/CAM and hybrid circuits.

On the other hand, components and packaging, and semiconductors are of strong interest to Army and Air Force.



Funding levels for each of the technical areas are shown here graphically. Army funding is shown in the lower part of each bar, Air Force funding in the upper part, and Navy in-between.

Components and packaging comprises the largest segment of the program, almost 19 million dollars worth. Microwave devices and TWTs is next with 15 million dollars, semiconductors with 12 million, electronics CAD/CAM with 11 million, electro-optics also 11 million, and hybrids 6 million dollars.

TECHNICAL TRENDS IN ELECTRONICS

AREA	NO OF PROJECTS FY81	FY82	COST IN MILLIONS FY81	FY82
COMPONENTS AND PACKAGING	30	21	$ 11.5	$18.6
MICROWAVE DEVICES	28	21	17.4	14.9
SEMICONDUCTORS AND ICS	25	16	14.6	12.2
ELECTRONICS CAD/CAM	12	16	8.0	11.4
ELECTRO-OPTICS	50	26	24.5	11.0
HYBRID CIRCUITS	10	9	4.3	6.2
TOTAL	155	109	$80.3	$74.3

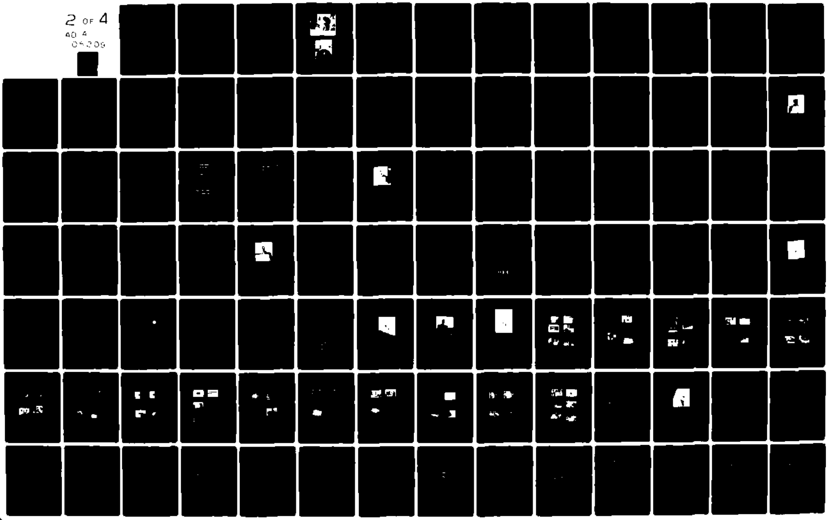
A GENERAL DOWN-TURN HAS BEEN NOTED IN THE MMT PROGRAM THIS YEAR. THE NUMBER OF PROJECTS ASSIGNED TO THE SIX TECHNICAL AREAS DROPPED FROM 155 TO 109 AND THE DOLLAR AMOUNTS FROM $80 MILLION TO $74 MILLION. NOTE THAT THESE ARE PROJECT ASSIGNMENT NUMBERS AND NOT ACTUAL DOLLARS.

ACTUALLY, THE DROP IN NUMBER OF PROJECTS FROM 163 TO 83 AND THE FUNDING FROM $64 MILLION TO $52 MILLION (SHOWN ON CHART 3) IS NOT QUITE SO DRASTIC. THE $52 MILLION STILL LEAVES US A SIZABLE PROGRAM.

AD-A105 209 DEPARTMENT OF DEFENSE WASHINGTON DC F/G 13/8
PROCEEDINGS OF THE ANNUAL TRI-SERVICE MANUFACTURING TECHNOLOGY --ETC(U)
OCT 80

UNCLASSIFIED NL

2 OF 4
AD A
105209



FY82 BUDGETED ELECTRONICS AND ELECTRO-OPTICS PROJECTS
$ MILLION

TECHNICAL AREA*	ARMY	NAVY	AIR FORCE	TOTAL
COMPONENTS AND PACKAGING	$ 3.8	$ 3.7	$11.1	$18.6
MICROWAVE DEVICES	8.4	4.7	1.8	14.9
SEMICONDUCTORS AND ICS	8.6	0.9	2.7	12.2
ELECTRONICS CAD/CAM	4.4	6.1	0.9	11.4
ELECTRO-OPTICS	6.4	2.8	1.8	11.0
HYBRID	4.5	0	1.7	6.2
TOTAL	$36.1	$18.2	$20.0	$74.3

* THERE IS SOME OVERLAP BETWEEN TECHNICAL AREAS.

TAKE A CLOSER LOOK AT THE EMPHASIS PLACED ON THESE AREAS BY THE THREE SERVICES.

AIR FORCE HAS THE BULK OF THE WORK IN COMPONENTS AND PACKAGING WITH ITS BROAD INITIATIVE IN CIRCUIT BOARDS.

IN MICROWAVE DEVICES THE ARMY HAS A LITTLE LESS THAN HALF THE PROGRAM, AND NAVY IS HEAVILY INTERESTED IN TWTs.

ARMY HAS MOST OF THE WORK IN SEMICONDUCTORS AND ICS.

NAVY AND ARMY HAVE SIZABLE PROGRAMS IN ELECTRONICS CAD/CAM.

ARMY AND NAVY ARE INTERESTED IN ELECTRO-OPTICS, AND ARMY AND AIR FORCE HAVE WORK IN HYBRID CIRCUITS.

NOW THAT YOU HAVE A FEEL FOR THE RELATIVE BALANCE IN THE PROGRAM, LET'S TAKE A LOOK AT HOW THE SERVICES COORDINATE ALL THIS NEW WORK.

PROJECT COORDINATION MEETING

- 23-26 SEPTEMBER MEETING
- REVIEW COMMITTEE
  - AIR FORCE MAN-TECH ENGINEERS
  - NAVY SYSCOM AND CENTER REPS.
  - ARMY SUB-COMMAND REPRESENTATIVES
  - INDUSTRY MAN-TECH MANAGERS & VPS

During the last week in September, the coordination review was held in Denver. The review committee consisted of engineers from Air Force's man tech office, from three Navy commands and four centers, and from four Army subcommands and three labs.

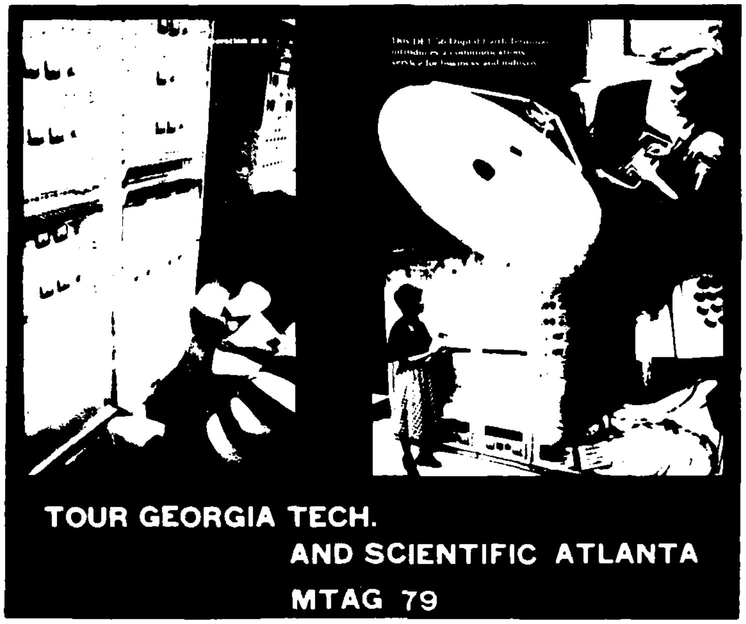
On the third day, the group held a joint meeting with thirty electronics industry association representatives --manufacturing technology managers and company vice-presidents. Working Group chairmen described their programs and named contact points for the different technical areas.

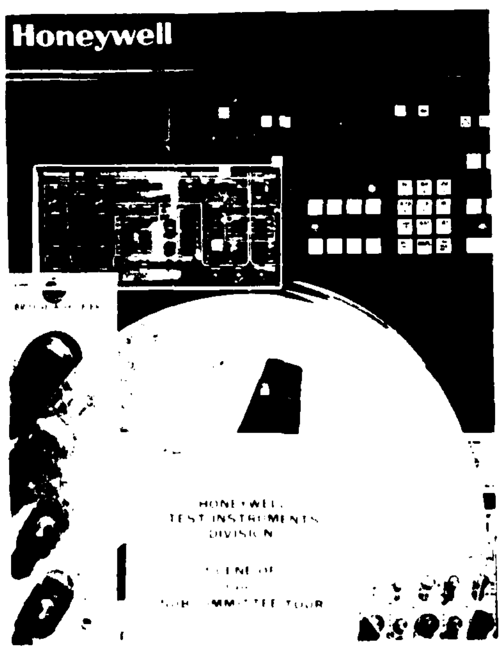
Air Force described its new emphasis on technology modernization at selected aircraft manufacturing plants. Tri-Service contracting effort in electronic CAD/CAM was described by Army managers with considerable industry interest.

ADVANCED TECHNOLOGY TOURS

1976	BELL LABS	HOLMDEL, NJ
1977	HONEYWELL	MINNEAPOLIS
1978	CONTROL DATA	MINNEAPOLIS
1979	SCIENTIFIC ATLANTA	ATLANTA
1980	HONEYWELL	DENVER

FOUR YEARS AGO, THE COMMITTEE TOURED BELL LABS' FACILITY AND SAW NEW DEVELOPMENTS IN FIBER OPTICS, WAVE GUIDES, AND SOLID STATE CENTRAL OFFICE EQUIPMENT. THREE YEARS AGO, THE COMMITTEE VIEWED AUTOMATED FUZE PRODUCTION, IN-PROCESS TESTING, AND ASSEMBLY OF LASER GYROS AND HEADS UP DISPLAYS AT HONEYWELL. TWO YEARS AGO THEY SAW SEMICONDUCTOR DIFFUSION, CHARGE COUPLE DEVICE AND BUBBLE FILM MEMORY MANUFACTURE AT CONTROL DATA. LAST YEAR THEY OBSERVED SATELLITE EARTH STATION COMMUNICATIONS EQUIPMENT, HIGH FREQUENCY ELECTRONICS, AND ANTENNAS BEING BUILT. THIS YEAR THE COMMITTEE SAW TEST AND RECORDING INSTRUMENTATION BEING ASSEMBLED AND RECEIVED A PREVIEW OF HONEYWELL'S NEW AUTOMATED CIRCUIT BOARD ASSEMBLY FACILITY. SAMPLE BOARDS WERE OBSERVED BEING CHECKED OUT ON A COMPUTERIZED TESTER.


TOUR GEORGIA TECH.
AND SCIENTIFIC ATLANTA
MTAG 79


Honeywell

	ACTIVITY	INDIVIDUAL
ARMY	MT OFFICE	MR. FREDERICK MICHEL
	IBEA	MR. CHARLES MC BURNEY
	IBEA	MR. STEPHEN YEDINAK
	ARRADCOM	MR. NATHANIEL SCOTT
	ERADCOM	MR. JOHN TETTI
	ERADCOM	MR. JOSEPH KEY
	ERADCOM	DR. HERBERT METTE
	ERADCOM	MR. LOTHAR WANDINGER
	ERADCOM	MR. LOUIS JASPER
	CORADCOM	BURT RESNIC
	CORADCOM	MR. AL FEDDELER
	CORADCOM	MR. JAMES KELLY
	MIRADCOM	MR. GORDON LITTLE
	NVL	MR. SHELDON KRAMER
	HDL	MR. JULIUS HOKE

	ACTIVITY	INDIVIDUAL
AIR FORCE	AFWAL	MAJ JOHN ERBACHER
	AFWAL	MR. DONALD KNAPKE
	AFWAL	MR. JACK GARRETT
	AFWAL	MR. HOWARD STEARNS
	AFWAL	MR. JOHN CRIST
NAVY	NAVMAT	MR. WILLIAM SAFIER
	NAVMIRO	MR. OSCAR WILSKER
	NAVELEX	MR. RAYMOND HILL
	NAVELEX	MR. CARL RIGDON
	NAVAIR	MR. GEORGE CUDD
	NOSC	MR. RICHARD GAMBLE
	NOSC	MR. OLOF LINDBERG
	NOSC	MR. PATRICK REAVES
	NOSC	MR. JUAN TROY
	NOSC	MR. ROBERT UNGER
	NAC	MR. LARRY HALBIG
	NWC	DR. WILLIARD WEBSTER
	NWSC	MR. EARL RIGGS
	NRL	DR. AARON ZUTKOFF
	NRL	MR. MANUEL PABLO

HERE'S A CLOSER LOOK AT THE ACTIVITIES REPRESENTED AND THE INDIVIDUALS PARTICIPATING. THESE EXPERTS SPENT FOUR HALF-DAYS REVIEWING THE PROGRAM. ALMOST EVERY ORGANIZATION SUBMITTING ELECTRONICS PROJECTS WAS REPRESENTED.

HERE'S THE REVIEW PROCEDURE THEY USED.

PREVIEW PROCEDURES

- **PRE-REVIEW**

  PROJECTS ARE DIVIDED BY TECHNICAL AREA, SENT TO WORKING GROUP MEMBERS AND STUDIED PRIOR TO THE MEETING.

- **REVIEW**

  MEMBERS GROUP BY AREA OF EXPERTISE, REVIEW PROJECTS, PROVIDE BACKGROUND AND COORDINATION CONTACTS, INDICATE ACCEPTANCE OR REJECTION OF PROJECT.

- **POST-REVIEW**

  WORKING GROUP CHAIRMEN FORMALIZE THEIR RECOMMENDATIONS AND ENSURE COORDINATION.

The procedure consisted of three parts: pre-review, the actual coordination review, and post-review. As soon as the projects or books were available from the Services, the electronics pages were removed and assigned to one or more of six technical areas. They were reproduced and sent to working group members who checked them prior to the meeting.

At the coordination review, members joined their working group and discussed the project proposals. They wrote brief summaries of the work and provided background information on the projects they were familiar with. They idenfified the processes, materials, and end items to be built. They also provided contact points for coordination purposes.

Following the review, working group chairmen formalized their reports and followed thru on coordination actions. It is the responsibility of the working group chairmen to insure coordination of the projects, and to recommend consolidation, redirection or dropping of overlapping efforts, and to report these actions to the full subcommittee.

Ultimately, it is up to the manufacturing technology offices to withhold funding from unworthy proposals.

FY82 COORDINATION SCHEDULES:

TUESDAY 23 SEPT.

[illegible]

WEDNESDAY 24 SEPT.

[illegible]

PM WEDNESDAY 24 SEPT.

[illegible]

THE CHARTS SHOW THE BUSY COORDINATION ACTIVITIES OF THE SUBCOMMITTEE. THE FIRST DAY SAW THE WORKING GROUP CHAIRMEN PRESENTATIONS IN WHICH THEY DETAILED THEIR RECENT COORDINATION ACTIVITIES. ARMY PROJECTS WERE REVIEWED IN THREE SIMULTANEOUS SESSIONS AND THEN IN THREE OTHER SIMULTANEOUS SESSIONS.

THE SECOND DAY SAW THE REVIEW OF AIR FORCE PROJECTS IN THREE TECHNICAL AREAS, AND LATER IN THREE OTHER AREAS. THIS WAS DONE SO THAT EACH INDIVIDUAL COULD COVER TWO AREAS.

THE AFTERNOON COVERED REVIEW OF NAVY PROJECTS AND THE PREPARATION OF WORKING GROUP PRESENTATIONS TO THE INDUSTRY REPRESENTATIVES ON THE FOLLOWING DAY.

ELECTRONICS WORKING GROUPS

- **ELECTRO-OPTICS AND OPTICS**
  MR. MANUEL PABLO, PHYSICIST, NRL
- **TRAVELING WAVE TUBES AND MICROWAVE DEVICES**
  DR. WILBUR WATSON, HEAD OF MICROWAVE DEVICES DIVISION, NOSC
- **SEMICONDUCTORS AND INTEGRATED CIRCUITS**
  MR. OLOF H. LINDBERG, ELECTRONICS ENGINEER, NOSC
- **COMPONENTS AND PACKAGING**
  MR. GORDON LITTLE, SUPERVISOR ELECTRONICS ENGR, MICOM
- **ELECTRONICS CAD/CAM**
  MR. FREDERICK MICHEL, ARMY MANUFACTURING TECHNOLOGY OFFICE.
- **HYBRID CIRCUIT**
  DR. VICTOR RUWE, CHIEF, MICROELECTRONICS DEVELOPMENT LAB. MICOM

THE MANAGEMENT CONCEPT USED BY THE SUBCOMMITTEE IS TO EMPLOY CAPABLE INDIVIDUALS TO MONITOR AND COORDINATE THE TECHNICAL AREAS WITHIN THE ELECTRONICS AND OPTICS PROGRAM.

THE ELECTRO-OPTICS WORKING GROUP IS CHAIRED BY MR. MANUEL PABLO OF NAVAL RESEARCH LABS, WASHINGTON.

THE COMPONENTS AND PACKAGING WORKING GROUP CHAIRMAN IS MR. GORDON LITTLE OF THE ARMY MISSILE COMMAND.

THE SEMICONDUCTORS AND INTEGRATED CIRCUITS WORKING GROUP CHAIRMAN, MR. OLOF LINDBERG, IS FROM THE NAVAL OCEAN SYSTEMS CENTER AND IS ALSO HEAVILY INVOLVED IN THE VHSI PROGRAM.

THE MICROWAVE DEVICES WORKING GROUP CHAIRMAN IS DR. WIL WATSON, ALSO FROM THE NAVAL OCEAN SYSTEMS CENTER WHERE HE MANAGES THE NAVY'S MICROWAVE R&D PROGRAM.

THE HYBRID CIRCUITS WORKING GROUP CHAIRMAN IS DR. VICTOR RUWE OF THE ARMY MISSILE COMMAND WHERE HE MANAGES THE MICROELECTRONICS LAB.

THE CHAIRMAN OF THE ELECTRONICS CAD/CAM INTERFACE GROUP IS MR. FREDERICK MICHEL OF ARMY'S OFFICE OF MANUFACTURING TECHNOLOGY.

TECHNICAL AREA	PROJECTS ASSIGNED	DOLLAR VALUE ASSIGNED	PROJECTS REVIEWED	DOLLAR VALUE REVIEWED
COMPONENTS & PACKAGING	21	$18,476K	21	$18,476K
ELECTRO-OPTICS	20	9,824	26	10,938
ELECTRONICS CAD/CAM	14	10,820	16	11,370
HYBRID CIRCUITS	8	4,911	9	6,150
MICROWAVE DEVICE	24	18,581	21	14,882
SEMICONDUCTORS & IC'S	19	14,050	16	12,133

HERE'S A SCORECARD I LIKE TO KEEP. IT RELATES THE NUMBER OF PROJECTS ASSIGNED TO THE VARIOUS WORKING GROUPS AND THE NUMBER ACTUALLY REVIEWED. SOME DILIGENT GROUPS PICK UP PROJECTS FROM THEIR MEMBERS OR FROM OTHER GROUPS. NOTE THAT THE ELECTRO-OPTICS TEAM COORDINATED SIX ADDITIONAL PROJECTS, PROBABLY CARRIED TO THE REVIEW SESSION BY WORKING GROUP MEMBERS.

OTHERS LIKE MICROWAVES OR SEMICONDUCTORS FELT THEY DIDN'T HAVE THE EXPERTISE TO FULLY REVIEW OR COORDINATE THE WORK OR FELT THE PROPOSALS WERE MISASSIGNED. THESE ARE THE REASONS OUR TOTALS AREN'T ALWAYS IDENTICAL.

AREAS OF TRI-SERVICE INTEREST

- **IN SEMICONDUCTORS:**

MICROWAVE IC'S	LAYOUT OF MICROWAVE IC'S	N
	GALLIUM ARSENIDE IC'S	A
	AUTOMATED MANUFACTURING TECHNIQUES	AF

- **IN MICROWAVE DEVICES:**

MICROWAVE IC'S	MICROWAVE IC AMPLIFIER	A
	MICROWAVE IC MODULE	AF
	MICROWAVE IC ASSEMBLY AND TEST TECHNIQUES	N

AREAS OF TRI-SERVICE INTEREST

In components and packaging, mundane printed circuit board manufacture and assembly are finally getting the attention they deserve. Army is working on multilayer circuit board materials, laminating processes and alignment techniques for fine line digital boards. Air Force is optimizing printed wiring board manufacturing process controls and assembly operations, and Navy will establish automated processes for fabricating microwave circuit boards.

In electronics computer aided design and manufacture, the three Services are supporting the ECAM project being contracted by MICOM. Army's project concentrates on assemblies such as hybrids and integrated circuits, Air Force will support the program definition phase, and Navy will work on circuit assemblies for sonobuoys and on their electrical alignment.

AREAS OF TRI-SERVICE INTEREST (CONT.)

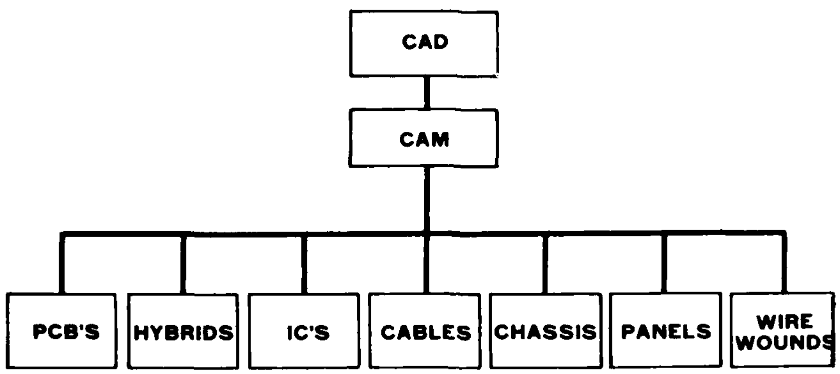
In semiconductors, the three Services are again in FY82 interested in microwave integrated circuits. Army will automate many of the processes for fabricating a 4-36 GHz amplifier in semi-insulating Gallium Arsenide. Navy will concentrate on layout of a family of functions to be designed into custom microwave ICs. Air Force will be looking at a whole range of automated processes for manufacturing electronic warfare modules.

In microwave devices, the emphasis is on high frequency module manufacture while in the semiconductor area noted above, the emphasis is on semiconductor processes. In the microwave IC work described here, Army is concentrating on automated fabrication of a small, high frequency amplifier for modular communications and navigation systems. Air Force will production engineer a microwave module for an advanced missile, while Navy will work on both assembly and test techniques. These three projects are being coordinated closely to insure maximum cross-fertilization of concepts and production processes.

ECAM

In Electronics Computer Aided Design and Manufacture, major emphasis is on the Tri-Service programs to apply computer assisted design and computer assisted manufacture to the production of seven types of electronics components. During the first year a consortium will study CAD/CAM of printed circuit boards, hybrid circuits, semiconductor integrated circuits, cables and harnesses, chassis, panels and covers, and wire wound items.

FY80 and 81 are funding the development of a master plan; FY82 will address the discrete projects above, and subsequent years will fill in the voids in the plan. How much is done will be determined by the Tri-Service support this program receives.



AREAS OF MUTUAL INTEREST

- **IN ELECTRO-OPTICS:**

OPTICAL SURFACING	COMPUTERIZED PITCH BUTTONING & BLOCKING	A
	HIGH SPEED POLISHING & COMPUTERIZED TESTING DIAMOND TURNING	N
FIBER OPTICS	FIBER OPTIC LINKS	AF
	SHIPBOARD INSTALLATION PROCESSES	N
NEODINIUM YAG LASER RODS	AUTOMATED ROD MODULE ASSEMBLY	A
	AUTOMATED ROD TESTING	N
MERCURY-CADMIUM-TELLURIDE	ARRAYS	AF
	QUADRENT DETECTORS	A
INFRARED DECTORS	DIODE ARRAYS	AF
	DETECTORS	A

There are a number of areas where two Services have an interest; they are working jointly on efforts that permit. These are the areas in FY82:

In electro-optics, Army and Navy will work on optical surfacing; Army will apply computer techniques to pitch buttoning and blocking operations, while Navy will concentrate on high speed polishing, computerized testing, and diamond turning.

In fiber-optics, Air Force will work on fiber optics links while Navy is working on shipboard applications.

In laser rods, Army is interested in the steps used in neodinium YAG rod module assembly, while Navy will work on automated rod testing.

Air Force has been working on mercury-cadmium-telluride material and diode arrays for a number of years while Army has been developing second and third sources for this material at Hughes and Honeywell. In FY82 Army will work on quadrant detectors fo the same material.

In infrared detectors made of silicon, Air Force will work on diode arrays and Army on more simple detectors.

AREAS OF MUTUAL INTEREST

- **IN HYBRID CIRCUITS: NONE**
- **IN COMPONENTS AND PACKAGING:**

CRYSTAL OSCILLATOR	STRESS COMPENSATED OSCILLATOR	AF
	TEMPERATURE COMPENSATED MICROPROCESSOR	A

- **IN MICROWAVE DEVICES:**

MILLIMETER WAVE SEEKERS	PIN DIODE	A
	IMPATT DIODE	A
	IMPATT DIODE	AF

IN HYBRID CIRCUITS, THE SERVICES DO NOT APPEAR TO HAVE ANY PROJECTS OF COMMON INTEREST THIS YEAR. DOESN'T THIS INDICATE STRONG COORDINATION?

IN COMPONENTS AND PACKAGING, THERE IS ONLY ONE AREA OF MUTUAL INTEREST AND THAT IS CRYSTAL OSCILLATORS. AIR FORCE WILL DEVELOP AUTOMATED PROCEDURES FOR BUILDING AND TESTING STRESS COMPENSATED OSCILLATORS, AND ARMY WILL AUTOMATE EQUIPMENT FOR PROGRAMMING A MICROPROCESSOR TO COMPENSATE AN OSCILLATOR FOR VARIATIONS IN TEMPERATURE. EACH CRYSTAL OSCILLATOR CIRCUIT WILL HAVE ITS OWN COMPENSATION SOFTWARE TAILORED EXACTLY AS NEEDED.

MICROWAVE DEVICES SEES THE ARMY WORKING ON PIN DIODES FOR DETECTORS IN MILLIMETER WAVE SEEKERS. THIS IS A SECOND YEAR EFFORT. ARMY WILL CONCENTRATE ON MOLECULAR BEAM EPITAXY PROCESSES. AIR FORCE'S MILLIMETER WAVE SEEKER PROJECT CONCENTRATES ON THE 94 GHz IMPATT DIODE. ARMY IS ALSO APPLYING ECOM-PRODUCED IMPATT DIODES TO AN ANTENNA ARRAY FOR A MULTI-ENVIRONMENT SEEKER.

SUCCESSFUL JOINT EFFORTS

- MILLIMETER WAVE SEEKERS
- MILLIMETER WAVE MIXERS
- TWT AMPLIFIERS
- CO-AXIAL MAGNETRONS
- HIGH PURITY SILICON
- AUTOMATED CRYSTAL DRAWING
- LITHIUM BATTERIES
- CERAMIC CHIP CARRIER
- RING LASER GYRO

Here are some of the areas where joint efforts resulted from prior year coordingation.

Air Force and Army will contract with a firm to develop production methods for millimeter wave seekers, and with another firm for millimeter wave mixers.

Air Force and Navy worked on Traveling Wave Tube Amplifiers; Navy ran the contract with Hughes. Navy also contracted for work on coaxial magnetrons with Air Force and Navy money.

Air Force and Army recently completed a joint effort in High Purity Silicon at Hughes with Air Force supervising the contract and Army providing the funds. A new contract has been let to automate the crystal drawing process to further reduce the wafer price. The work built a base in the United States for this critical detector material.

You may recall the work on Lithium Batteries. Army contracted to Power Conversion Company and Air Force provided part of the money. Lithium Batteries are now in adequate supply.

The Ceramic Chip Carrier work contracted to Hughes, RCA, and T.I. by Air Force with Air Force and Navy funds, has been successfully adopted by industry. Chip carriers have become a standard packaging method.

PROJECTS DROPPED AFTER COORDINATION

ARMY	E 81 3772	INTEGRATED POWER SWITCH	$ 358K
NAVY	DNE 0057	AUTOMATED OPTICAL INSPECTION OF PRINTED CIRCUIT BOARDS	1,200
	DNE 0154	METAL OPTICS ELECTRO-POLISHING	280
	DNE 0133	HIGH SPEED OPTICAL SURFACING	1,200
	DNE 0134	RF PACKAGING WITH PLASTIC ENCLOSURES	——
	DNS 0580	MULTI-WIRE CIRCUIT BOARD	375
	DNE 0000	BROADBAND IR SOURCE	——
AIR FORCE	02E 602-1B085250	MILLIMETER WAVE SEEKER (94 GHZ DIODES)	$ 300

THIS LIST OF PROJECTS DROPPED FOLLOWING LAST YEAR'S COORDINATION EFFORT, ALTHOUGH INCOMPLETE, IS IMPRESSIVE.

IT SHOWS THAT 3 TO 4 MILLION DOLLARS WAS REDIRECTED TO MORE PRESSING AREAS OF WORK.

NAVY GETS THE CREDIT FOR BEING MOST ACTIVE IN THE AREA OF PROGRAM REDIRECTION. THIS RESULTED IN PART FROM A $9 MILLION PROGRAM REDUCTION. BUT KNOWING WHAT PROJECTS TO REDUCE WITHOUT DAMAGING THE OVERALL PROGRAM IS IMPORTANT. MEMBERS OF THE SUBCOMMITTEE WERE ABLE TO PROVIDE THAT REDIRECTION.

TECHNOLOGY OPPORTUNITIES

- VERY HIGH SPEED INTEGRATED CIRCUITS
- IN-PROCESS CONTROL
- AUTOMATED ASSEMBLY
- OPTICAL INSPECTION
- AUTOMATIC TEST

The Services haven't fully covered the field of electronics, even with eighty-three new projects in FY82. Very high speed integrated circuit technology is being addressed in a number of R&D projects, and will soon require MMT work, but MM&T proposals are being deferred until the R&D shows definite direction. This is delaying our planning efforts.

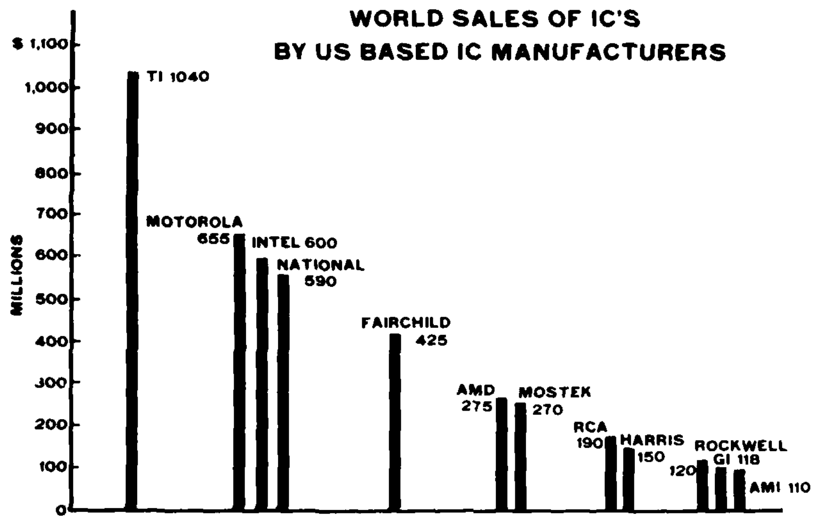
There is need for more in-process control where accurate monitoring of process parameters can give large improvements in productivity. Current work shows good results and fast payback.

Automated assembly should be addressed continuously; we have worked on printed circuit stuffing and hybrid circuit assembly using chip and film carriers. Flexible assembly should also be pushed.

Optical inspection was sponsored by Armament and Electronics Commands and systems are able to check thick and thin film circuits, printed circuits, optics, bullet jackets and other items but additional work will enhance our productivity.

Automatic test is such a large area that the work we have done is only a beginning. The EQUATE system developed by Army and RCA has sold some 50 systems, and now a more economical system will be developed.

The Services are addressing all these areas in their future plans and will interface with the Test and Inspection Subcommittee on these last two.



FROM ICE NEWSLETTER, APRIL 1980

SEMICONDUCTOR SHIFTS

WITH THE CAPABILITY OF MICRO-PROCESSORS AND MINI-COMPUTERS BEING CONTINUOUSLY EXTENDED AND THE DEVICES BEING INCORPORATED IN MANY NEW PRODUCTS, SYSTEMS HOUSES HAVE FOUND THEY NEED A CAPTIVE OR IN-HOUSE CAPABILITY TO GET FAST, COOPERATIVE RESPONSE TO THEIR NEEDS. SUBSEQUENTLY, THEY ACQUIRE A SEMICONDUCTOR FIRM HAVING LARGE SCALE INTEGRATION CAPABILITY. THESE ACQUISITIONS MAY BE LEADING TO A REDUCTION OF COMPETITION AND PRODUCTION CAPACITY FOR MILITARY LSI CIRCUITS BECAUSE CAPTIVE HOUSES SELDOM PRODUCE COMPONENTS FOR OUTSIDERS. THERE IS THUS A NEED TO MAINTAIN THE BALANCE BETWEEN DEMAND AND SUPPLY CAPABILITY. THE MMT AND ECAM PROGRAMS CAN BE INSTRUMENTAL IN EXTENDING THE CAPABILITY OF MEDIUM CAPACITY HOUSES TO DEVELOP AND PRODUCE PROTOTYPE CIRCUITS WITH RAPID RESPONSE, AND LATER TO SUPPLY PRODUCTION QUANTITIES.

SCARCE AND CRITICAL MATERIALS

HYBRIDS	**GOLD-CONTAINING INKS**
PRINTED CIRCUITS	**GOLD-PLATED CONTACTS**
PACKAGES	**GOLD-PLATED LEADS**

HYBRID CIRCUITS USE GOLD-CONTAINING INKS, PRINTED CIRCUITS USE GOLD-PLATED CONTACTS, AND MANY COMPONENTS USE GOLD-PLATED LEADS. THUS, GOLD IS IN SUBSTANTIAL DEMAND FOR ELECTRONICS PRODUCTION AND WITH ITS RAPID RISE IN PRICE HAS BECOME SO COSTLY AS TO BE ALMOST PROHIBITIVE. SEVERAL PROJECTS ARE AIMED AT SUBSTITUTES FOR GOLD IN THICK-FILM INKS AND AT NEW PROTECTIVE MATERIALS FOR CIRCUIT BOARDS AND COMPONENT LEADS.

YEAR-LONG COORDINATION EFFORTS

SEP 79	COORDINATE FY 81 ELECTRONICS PROGRAM
OCT 79	ANNUAL MEETING
FEB 80	THIRD ANNUAL DOD MICROELECTRONICS PLANNING CONFERENCE
FEB 80	GOVERNMENT/INDUSTRY PACKAGING MEETING FOLLOWING IPC MEETING
JAN 80	TWT WORKSHOP FOLLOWING POWER TUBE CONFERENCE
MAR 80	TWT WORKSHOP
AUG 80	DISTRIBUTE PROJECTS
SEP 80	REVIEW AND COORDINATE FY82 PROGRAM
OCT 80	CIRCULATE WORKING GROUP COMMENTS FOR COORDINATION
OCT 80	ANNUAL MEETING
NOV 80	DISTRIBUTE COORDINATION MEETING RESULTS
FEB 81	FOURTH ANNUAL DOD MICROELECTRONICS PLANNING CONFERENCE
FEB 81	GOVERNMENT/INDUSTRY COMPONENTS AND PACKAGING MEETING

Coordination doesn't take place during one or two meetings, and rest during the remainder of the year. Some important activity is going on almost every month.

For example, in addition to the coordination meeting in September of 1979 and the Annual Meeting in October '79, there were six working group planning meetings and three conferences. Then the review and coordination cycle for FY82 started in August of this year. Committee comments are being circulated to Tri-Service representatives and will be corrected and returned and will then be distributed for further coordination. Results of this last interaction will be made available to the MTAG executive committee, and to the senior representatives at the commands and manufacturing technology offices.

A QUOTATION:

• • • I WAS IMPRESSED BY THE DESIRE OF THE VARIOUS SERVICE REPRESENTATIVES TO SHARE INFORMATIONS FROM THEIR INDIVIDUAL ORGANIZATIONS,

• TO TRULY COORDINATE AND AVOID DUPLICATION WHERE POSSIBLE, AND IN GENERAL

• TO ASSURE MAXIMUM UTILIZATION OF IMPROVED MANUFACTURING TECHNOLOGY THROUGHOUT THE GOVERNMENTAL ORGANIZATIONS INVOLVED.

MR. DON WILLYARD,
BENDIX, KANSAS CITY DIV.,
FOR THE DEPARTMENT OF ENERGY.

INDUSTRY INTERFACE

THE ELECTRONIC INDUSTRIES ASSOCIATION AND THE ELECTRONICS SUBCOMMITTEE INTERACT CLOSELY IN THEIR EVERYDAY OPERATIONS. THE EIA HAS ESTABLISHED TASK TEAMS TO ASSESS TECHNOLOGY IN THE AREAS DEFINED BY THE WORKING GROUPS. THEY HAVE THOROUGHLY REVIEWED THE ENTIRE FY81 PROGRAM AND WILL REPORT TO THIS ASSEMBLY TOMORROW. THEY ALSO HAVE THE EXPERTISE TO ASSES THE STATE-OF-THE-ART IN THESE AREAS AND SUGGEST NEW TECHNOLOGIES THEY FEEL THE SERVICES SHOULD ADDRESS.

DOE INTERFACE

THE SUBCOMMITTEE WAS RECENTLY ASSIGNED A DEPARTMENT OF ENERGY INTERFACE ENGINEER IN THE PERSON OF MR. DONALD A. WILLIARD OF THE BENDIX KANSAS CITY DIVISION, AN OPERATING CONTRACTOR FOR DOE IN THIS AREA. MR. WILLIARD PARTICIPATED IN THE 1980 COORDINATION MEETING AT DENVER AND HAD THIS TO SAY ABOUT THE REVIEW: SEE PAGE FACING.

ADPA HAS ALSO ESTABLISHED AN INTERFACE INDIVIDUAL; HE IS MR. G. R. GASCH... SENIOR STAFF MEMBER OF THE PROTOTYPE CENTER AT RAYTHEON'S MISSILE SYSTEMS DIVISION.

END OF CONTRACT DEMONSTRATIONS

SCHEDULED FOR 1980

	ARMY	NAVY	AF
ELECTRONICS & COMMUNICATIONS	17	16	6
AMMUNITION	17	1	
WEAPONS	6	1	
AIRCRAFT	2	1	4
MISSILES	2	0	3
SHIPS	0	9	
	44	28	

Shown here are the number of debriefings held by companies completing MMT contracts in 1980. Army contractors have scheduled 17 in electronics, a third of their total of 44 briefings. Navy contractors have scheduled 16, over half of their total of 28. Air Force has scheduled 6, also about half of their total. Complete data will be available in the Annual Report. These briefings aid immensely in technology transfer, and I encourage you to accept the invitations you receive in your area of expertise.

ELECTRONICS DISPLAYS

GENERAL DYNAMICS, POMONA	BUMPED TAPE AUTOMATED BONDING. PLASTIC MICROWAVE COMPONENTS.
HARRIS SEMICONDUCTOR	*DIODE PHASE SHIFTERS.* IR CIRCUIT TESTER.
RCA	CMOS/SOS ON SAPPHIRE CIRCUIT PRODUCTION.
VARIAN ASSOCIATES	CROSS FIELD AMPLIFIERS.
WESTINGHOUSE	MNOS ICs FOR BORAM.

SHOWN HERE ARE THE FIVE FIRMS HAVING DISPLAYS RELATED TO ELECTRONICS. YOU ARE ACQUAINTED WITH THE BUMPED TAPE WORK DONE BY GENERAL DYNAMICS FOR THE NAVY. THIS WILL ALSO BE ILLUSTRATED IN A MINISYMPOSIUM PAPER.

HARRIS SEMICONDUCTOR HAS A BOOTH ILLUSTRATING THEIR IR CIRCUIT TESTER AND DIODE PHASE SHIFTER WORK. HARRIS PRD ELECTRONICS DIVISION WILL PROVIDE A PAPER ON PROGRAMMING AIDS AT THE MINISYMPOSIUM.

RCA HAS A DISPLAY ON INTEGRATED CIRCUIT PRODUCTION, SPECIFICALLY, COMPLEMENTARY METAL OXIDE ON SAPPHIRE.

VARIAN HAS A HEAVY SAMPLE OF A CROSS FIELD AMPLIFIER, AND WESTINGHOUSE A FINE DISPLAY ON THEIR EXPANDABLE ICs FOR MEMORIES.

ELECTRONICS MINI-SYMPOSIUM
22 October 1980, Bal Masque Room, Sheraton-Bal Harbor
Bal Harbor, Florida

SESSION 1 HYBRID CIRCUIT TECHNOLOGY

8:30	Advanced Hybrid Manufacturing Technology
9:00	New Manufacturing Technology in Hybrid Packaging
9:30	Trade-Off Considerations for the Selection of BTAB Interconnects on Hybrids
10:00	Refreshments

SESSION 2 SEMICONDUCTORS AND INTEGRATED CIRCUITS

10:20	Non-Volatile MNOS for BORAM for AIRS

SESSION 3 COMPONENTS & PACKAGING

10:45	Flexible Circuits with Integral Connectors
11:10	Manufacturing Technology for Electronic Component Finishes
11:35	Future Battery Technology for the Military
12:00	Luncheon

SESSION 4 ELECTRONIC CAD/CAM TECHNOLOGY

1:30	Computer Aid for Preparation of Automatic Analog Circuit Production Test Programs
1:55	An Automated System for Hybrid Circuit Visual Inspection
2:20	Automatic Monitoring and Control System for Wave Soldering Machines

SESSION 5 TWT AND MICROWAVE DEVICE TECHNOLOGY

2:45	Aegis SFD-261 Crossed Field Amplifier MT Program
3:00	Refreshments. Continued with CFA paper.
3:20	Quick Turn-on Cathode for Missile Pulsed TWT
3:45	TWT Reliability in ECM System Applications

SESSION 6 ELECTRO-OPTICS AND OPTICS TECHNOLOGY

4:10	Fabrication of 18 mm Wafer Image Intensifier Tubes by Batch Processing Techniques
4:35	CO2 Laser Manufacturing Technology
5:00	Dismissal

Following are vugraphs showing the schedule and presentations by technology. Session 1 covers Hybrid Circuits, Session 2 Semiconductors, and Session 3 Components and Packaging which ends at noon.

Following the luncheon is session 4 on Electronics CAD/CAM, and session 5 on Microwave Devices. The symposium closes with Electro-optics. We encourage you to take advantage of these presentations with their films, slides and vugraphs illustrating results of MM&T contracts.

ELECTRONICS MINISYMPOSIUM TOPICS

HYBRID CIRCUIT TECHNOLOGY

ADVANCED HYBRID MANUFACTURING TECHNOLOGY	MR. W. W. AGERTON MICROELECTRONICS ENGR CORP.
NEW MANUFACTURING TECHNOLOGY IN HYBRID PACKAGING	MR. LOUIS A. RAZZETTI WESTINGHOUSE, BALTIMORE
TRADE-OFF CONSIDERATION FOR THE SELECTION OF BTAB INTERCONNECTS ON HYBRIDS	MR. GEORGE W. BRAUN GENERAL DYNAMICS, POMONA

ELECTRONICS MINISYMPOSIUM TOPICS

COMPONENTS AND PACKAGING

IMPLEMENTATION, THE KEY TO SUCCESS IN MANUFACTURING TECHNOLOGY (FLEXIBLE CIRCUITS WITH INTEGRAL CONNECTORS)	MR. JAMES A. HENDERSON WESTINGHOUSE, BALTIMORE
EVALUATION OF NICKEL BORON AS A PRIMARY FINISH ON COMPONENT LEADS	MR. LOUIS A. ZAKRAYSEK MR. N. C. BULSIEWICZ MR. R. E. VARNUM GENERAL ELECTRIC CO.
FUTURE BATTERY TECHNOLOGY FOR THE MILITARY	MR. LARRY PLEW NAVAL WEAPONS SUPPORT CENTER

ELECTRONICS MINISYMPOSIUM TOPICS

SEMICONDUCTORS AND INTEGRATED CIRCUITS

• NON-VOLATILE METAL NITRIDE OXIDE BLOCK ORIENTED RANDOM ACCESS MEMORY FOR ACCIDENT INFORMATION RETRIEVAL SYSTEM	MR. J. E. BREWER WESTINGHOUSE ELEC. CORP.

ELECTRONICS MINISYMPOSIUM TOPICS

ELECTRONIC CAD/CAM TECHNOLOGY

COMPUTER AID FOR PREPARATION OF AUTOMATIC ANALOG CIRCUIT PRODUCTION TEST PROGRAM	MR. JEFFREY KUNG HARRIS CORP., PRD ELECTRONICS DIV.
AN AUTOMATED SYSTEM FOR HYBRID CIRCUIT VISUAL INSPECTION	MR. JOHN M. LASKEY RCA, GOVT. SYSTEM DIV.
AUTOMATIC MONITORING AND CONTROL SYSTEM FOR WAVE SOLDERING MACHINES	MR. LOYD WOODHAM USA MICOM MR. E. W. BROACHE MR. A. T. HAMILL WESTINGHOUSE ELECT. CORP. DEFENSE & ELECT. SYST. CENTER

ELECTRONICS MINISYMPOSIUM TOPICS

ELECTRO-OPTICS AND OPTICS

• FABRICATION OF 18MM WAFER IMAGE INTENSIFIER TUBES BY BATCH PROCESSING TECHNIQUES	MR. H. GENE PARISH ELECTRON TUBE DIV., LITTON INDUSTRIES, PHOENIX
• CO_2 LASER MANUFACTURING TECHNOLOGY	DR. HANS MOCKER HONEYWELL SYSTEMS & RESEARCH CENTER, MINNEAPOLIS

TWT AND MICROWAVE DEVICE TECHNOLOGY

ELECTRONICS MINISYMPOSIUM TOPICS

AEGIS SFD-261 CROSSED FIELD AMPLIFIER MT PROGRAM	MR. R. A. LA PLANTE VARIAN ASSOCIATES
QUICK TURN-ON CATHODE FOR MISSILE PULSED TWT	MR. ROBERT M. PHILLIPS LITTON INDUSTRIES
TWT RELIABILITY IN ECM SYSTEM APPLICATIONS	MR. FRANK VOLTAGGIO, JR. NORTHROP CORP. MR. DONALD K. ROGERS TELEDYNE - MEC

INSPECTION AND TEST SUBCOMMITTEE OVERVIEW

by

MR. EDWARD CRISCUOLO

INTRODUCTION

In this presentation, I will concentrate on the review of 1982 proposed projects and highlights of projects that are completed or near completion. At this time, I will describe the objectives and operations of the subcommittee. The subcommittee is composed of representatives from the DoD services, other government agencies, and industry. Industry members operate the professional societies. During the year, we have had approximately four meetings to conduct our work. Most of the effort is directed to setting up workshops and the review of proposed projects. An annual report is prepared which gives a summary of our work along with recommendations.

OBJECTIVES

VU GRAPH 1 shows the objectives of the subcommittee which are:

To provide technical assessment and tri-service coordination of specific proposed Manufacturing Technology projects in the area of test and inspection. Through the examination of projects a determination is made for compatibility with DoD objectives, duplication of effort and potential for joint funding.

To provide an industry-government forum for the discussion of anticipated production problems and the identification of potential solutions and assess the impact of privately sponsored work on the areas of interest.

To make recommendations regarding joint service efforts, elimination duplication, and establishment of broad DoD Manufacturing Technology goals in test and inspection.

VU GRAPH 2 illustrates the classification methods used to analyze the proposed projects. The main divisions are by methods, materials and applications. When analyzed by methods, it was found over half the projects fell into the nondestructive category. The materials category enabled the T&I subcommittee projects to relate to the other subcommittees.

VU GRAPH 3 shows the number and dollar amount of new projects by service. In addition, the continuation projects are shown. In total there are twenty-seven continuation projects for $10.9M and twenty-four new proposed projects for $6.2M.

The review did not reveal any duplication or overlap of projects.

VU GRAPH 4 - In the next few vu graphs, a number of projects will be presented as highlights. These projects are completed or near completion. In the area of ordnance inspection, four projects are highlighted. The AIDECS is designed to inspect the explosive filling of a 105MM explosive shell using an x-ray detector system. This method is to be applied to larger caliber shells. The next three items are related to the inspection of 105MM cannons. The laser scan inspection system is a method for inspecting the internal bore of the gun tube for defects and cracks. The hot forging wall variation measurement utilizes the ultrasonic technique for measuring hot common tube forgings wall thickness. Adjustment to the forging operation can be made without waiting for the tube to cool. This results in a large cost savings.

The 105MM inspection station is designed to measure straightness, bore diameter, rifling diameter, concentricity, and breech end details.

VU GRAPH 5 - The objective of the Inertial Instrument Inspection and Test Project was to establish a automated inspection and test system for evaluating gas spin motor bearings in gyro float assemblies. The Wheel Evaluation Test Station (WETS) evaluates gas bearing geometry and surface conditions, motor characteristics and float assembly fill gas. The WETS system will provide improved inspection and test methods for gas spin motor bearings, improved reliability and reduced maintenance cost.

VU GRAPH 6 highlights the Ultrasonic Inservice Inspection System (ISIS) for composites. The ultrasonic technique can detect disbonds and delaminations in composites. For large structures as used in aircraft, the method is not considered cost effective primarily because of the lack of flaw position locating and permanent inspection results recording devices. Under this project a test device was developed to overcome the deficiencies. The technique is simple to apply in the field environment by personnel with advanced training.

VU GRAPH 7 highlights a mobile neutron radiographic device for use on aircraft to detect corrosion. This neutron generator is mobile and driven by an electrically operated cart. It is possible to use this device in the field or in the factory. Early detection of corrosion can save rework costs. A mobile unit developed under an Army contract is being field tested.

VU GRAPH 8 - There are a number of other projects that can be highlighted, but these will be presented in the minisymposium. In addition, the minisymposium will give much detail on the projects I have discussed plus a demonstration of the ISIS system.

VU GRAPH 9 shows the plans for the next year. You may not know that plans are being made for a workshop. The other meetings relate to a continuing review of revised programs.

OBJECTIVES OF THE TEST AND INSPECTION SUBCOMMITTEE

- PROVIDE TECHNICAL ASSESSMENT OF SPECIFIC PROPOSED MANUFACTURING TECHNOLOGY PROJECTS
- PROVIDE TRI-SERVICE COORDINATION OF PROJECTS
- PROVIDE INDUSTRY-GOVERNMENT FORUM FOR THE DISCUSSION OF PRODUCTION PROBLEMS AND IDENTIFICATION OF POTENTIAL SOLUTIONS
- PROVIDE RECOMMENDATIONS REGARDING JOINT SERVICES EFFORTS, ELIMINATION OF DUPLICATION, AND ESTABLISH BROAD DOD MT GOALS

CLASSIFICATION OF TEST AND INSPECTION PROJECTS

T&I PROJECTS

- METHODS
  - NONDESTRUCTIVE
  - METROLOGY
  - PROOF
  - ENVIRONMENTAL
  - SIMULATION
  - SYSTEM
  - MECHANICAL
  - CHEMICAL
  - PROCESS CONTROL
- MATERIAL
  - METALS
  - NONMETALS
  - COMPOSITES
  - ASSEMBLIES
- APPLICATIONS
  - AIRCRAFT STRUCTURES
  - ORDNANCE
  - ELECTRONICS
  - PROPULSION
  - SUPPORT EQUIPMENT
  - IN SERVICE

TEST AND INSPECTION PROPOSED PROJECTS FOR FY82

NAVY
- NO CONTINUATION PROJECTS
- ONE NEW PROJECT FOR $2.3M

AIR FORCE
- NINE CONTINUATION PROJECTS FOR $5.9M
- ONE NEW PROPOSED PROJECT FOR $.4M

ARMY
- EIGHTEEN CONTINUATION PROJECTS FOR $5.0M
- TWENTY-TWO NEW PROPOSED PROJECTS FOR $3.5M

TOTAL
- TWENTY-SEVEN CONTINUATION PROJECTS FOR $10.9M
- TWENTY-FOUR NEW PROPOSED PROJECTS FOR $6.2M

TEST AND INSPECTION HIGHLIGHTS

ORDNANCE INSPECTION

- 105MM AUTOMATIC INSPECTION DEVICE FOR EXPLOSIVE CHARGE IN SHELLS (AIDECS)
- LASER SCAN INSPECTION SYSTEM
- HOT FORGING WALL VARIATION MEASUREMENTS
- 105MM INSPECTION SYSTEM

TEST AND INSPECTION HIGHLIGHTS

INERTIAL INSTRUMENT INSPECTION AND TEST

(WHEEL EVALUATION TEST STATION, WETS)

TEST AND INSPECTION HIGHLIGHTS

ULTRASONIC IN–SERVICE INSPECTION SYSTEM

(ISIS) FOR COMPOSITES

TEST AND INSPECTION HIGHLIGHTS

MOBILE NEUTRON RADIOGRAPHY

TEST AND INSPECTION SUBCOMMITTEE MINISYMPOSIUM

22 OCTOBER 1980

TOPICS

- EDDY CURRENT SURFACE INSPECTION OF DISCS
- INTEGRATED BLADE INSPECTION (IBIS)
- MOBILE NEUTRON INSPECTION SYSTEM
- WHEEL EVALUATION TEST SYSTEM
- CANNON BARREL INSPECTION
- AUTOMATIC INSPECTION DEVICE FOR EXPLOSIVE CHARGE IN SHELLS (AIDECS)
- HIGH ENERGY REAL TIME RADIOGRAPHY
- IN-SERVICE INSPECTION SYSTEM

TEST AND INSPECTION ACTIVITIES
TENTATIVE SCHEDULE FOR FUTURE MEETINGS

17–18 SEPTEMBER 1980	– PLANNING MEETING FOR WORKSHOP CONFERENCE IBEA, ROCK ISLAND, ILLINOIS
28–30 APRIL 1981	– PLANS FOR MINISYMPOSIUM GENERAL DYNAMICS, SAN DIEGO, CALIFORNIA
21–23 JULY 1981	– FY 83 PROJECT REVIEW BATTELLE, COLUMBUS, OHIO
25–26 AUGUST 1981	– FINAL FY83 PROJECT REVIEW, MINISYMPOSIUM, THRUST AREA REPORTS, AND CONFERENCE PRESENTATION AMMRC, WATERTOWN, MASSACHUSETTS

METALS SUBCOMMITTEE OVERVIEW

by

MR. GORDON NEY

Good afternoon. Each year I look forward to having this opportunity to speak to you. In last year's presentation, I concentrated on the past. The subcommittee had completed five years of operation and I thought it worthwhile to review the progress we had made during that time.

This year, I would like to concentrate more on the future - the future of metals manufacturing technology, where it's headed and what some of the major thrusts in the Service's Metals Manufacturing Technology programs will be. This is appropriate since it is in tune with the theme of this year's MTAG Meeting - Productivity Growth in the 80's. Webster's New Collegiate Dictionary defines productivity as having the power or ability to produce in abundance. The enhancement of this ability is definitely the theme of metals manufacturing technology in the 80's.

Before delving into this subject, I want to briefly explain the functions of the Metals Subcommittee, summarize the metals programs for FY81 and FY82, and review our accomplishments for 1980.

OBJECTIVE

PROVIDING A FORUM FOR THE EXCHANGING OF TECHNICAL INFORMATION AND IDEAS AND MAXIMIZING THE USE OF ADVANCED MANUFACTURING TECHNOLOGY.

Our objective is to provide a forum for the exchanging of technical information and ideas and maximize the use of advanced manufacturing technology. We are attempting to prevent duplication, promote joint efforts where appropriate and stimulate the application of advanced manufacturing technology to problem areas not previously considered. We deal with all processes required to produce metal and structural ceramic products, but concentrate on those technologies that are common, or in our opinion, should be common among the services. Concentrating on these technologies enables us to favorably influence the individual service programs in a way that each service, individually, could not.

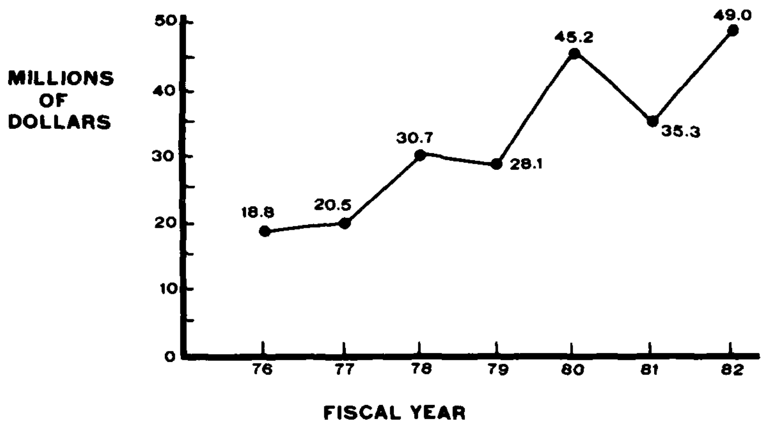
ACTIVITIES

- PROJECT REVIEW
- PROGRAM ANALYSIS
- WORKSHOPS AND SEMINARS

Three types of activities have evolved in accomplishing our objective. Individual projects are reviewed to eliminate potential duplication of effort. Program data is analyzed and presented here, and in our annual report, to stimulate discussion of the trends occurring in the Services' programs. Workshops and seminars are sponsored to create a dialogue between DOD and Industry about program accomplishments and future directions.

Our activities for a given year are established through a process that begins with a subcommittee meeting in late summer of each year. At this meeting, the Services' budget, apportionment and five year program plans are reviewed. Common areas of interest are identified and appropriate actions are recommended to the Executive Committee. Once approved, the actions are assigned to service representatives for execution. The results are then documented annually in the Metals Subcommittee Report.

FUNDING HISTORY
METALS PROGRAM



THIS CHART SHOWS THE RAGGED BUT CONTINUAL GROWTH OF THE SERVICES METALS PROGRAMS. IT APPEARS THAT THERE IS A TWO YEAR CYCLE. ONE YEAR THE PROGRAM SEEMS TO LOSE GROUND AND THE NEXT YEAR, IT SEEMS TO SHOW SUBSTANTIAL GROWTH. FY81 AND FY82 FIT THAT PATTERN.

FY81 PROGRAM CHANGES

	BUDGET		CURRENT	
	NUMBER	DOLLARS	NUMBER	DOLLARS
ARMY	66	17,616	52	15,336
NAVY	21	12,500	6	1,580
AIR FORCE	39	18,893	28	18,398
TOTALS	126	49,009	86	35,314

A YEAR AGO, THE METALS FY81 PROGRAM CONSISTED OF 126 PROJECTS WORTH 49 MILLION DOLLARS. IT NOW CONSISTS OF 86 PROJECTS WORTH 35 MILLION DOLLARS. IT IS OBVIOUS THAT THE BULK OF THE DOLLARS LOST IS ASSOCIATED WITH THE REDUCTION IN THE NAVY PROGRAM. THIS MORNING YOU HEARD ABOUT THE NAVY'S TROUBLES AND YET THEIR OPTIMISM FOR THE FUTURE. WHILE THE AIR FORCE'S BUDGET FOR FY81 APPEARS TO REMAIN THE SAME, THERE ARE SUBSTANTIAL DIFFERENCES REFLECTED IN THE NUMBER OF PROJECTS TO BE FUNDED. IN FACT, THE DOLLAR VALUE IS DECEIVING BECAUSE THE CURRENT PROGRAM INCLUDES ONE PROJECT FOR APPROXIMATELY 5 MILLION DOLLARS WHICH WILL BE FUNDED FROM AN OPERATIONS AND MAINTENANCE ACCOUNT - A SOURCE OF FUNDS NOT REFLECTED IN THE BUDGET PROGRAM. EXCLUSION OF THIS PROJECT SHOWS A SIGNIFICANT DECLINE IN WHAT THE AIR FORCE CALLS "GENERIC TECHNOLOGY," PARTICULARLY WHEN IT IS COMPARED TO A HIGH OF 21 MILLION DOLLARS ATTAINED IN FY80. THIS DECLINE COUPLED WITH THE UNCERTAINTY ASSOCIATED WITH THE NAVY'S PROGRAM HAS HAD AN ADVERSE IMPACT UPON THE SUBCOMMITTEE'S ABILITY TO ESTABLISH COOPERATIVE EFFORTS.

FY82 PROGRAM

	NUMBER	DOLLARS
ARMY	69	27,089
NAVY	2	2,450
AIR FORCE	25	19,484
TOTAL	96	49,023

THE FY82 METALS PROGRAM SEEMS TO HOLD FOR A BRIGHTER FUTURE. FUNDING IS UP SUBSTANTIALLY OVER THE CURRENT FY81 PROGRAM. IT STANDS AT 49 MILLION DOLLARS AND 96 EFFORTS. THE BULK OF THIS INCREASE IS DUE TO A 12 MILLION DOLLAR INCREASE IN THE ARMY'S PROGRAM. A LARGE PORTION OF THIS INCREASE IS ASSOCIATED WITH WHAT THE ARMY TERMS, "SYSTEMS" PROJECTS. THESE ARE PROJECTS AIMED AT SIGNIFICANTLY REDUCING THE COST OF A MAJOR WEAPONS SYSTEM THROUGH THE IMPLEMENTATION OF IMPROVED MANUFACTURING TECHNOLOGY. THEY ARE SIMILAR IN CONCEPT TO THE AIR FORCE'S TECHNOLOGY MODERNIZATION PROJECTS. THEY TEND TO INVOLVE MULTIPLE TECHNOLOGIES AND ARE NORMALLY FUNDED TO FILL THE NEEDS OF A SPECIFIC FACILITY. SINCE THIS TYPE PROJECT IS NORMALLY SELECTED FOR FUNDING BASED UPON THE ITEMS PRODUCED AND NOT ON THE MANUFACTURING TECHNOLOGIES TO BE INVESTIGATED, IT IS MORE DIFFICULT TO FORM COOPERATIVE EFFORTS BASED ON TECHNOLOGY. TO FORM COOPERATIVE EFFORTS FOR SUCH PROJECTS, IT IS MORE FRUITFUL TO LOOK FOR COMMONALITY AMONG THE SERVICES IN THE PRODUCTS PRODUCED AT THE SELECTED FACILITY THAN AT THE TECHNOLOGIES TO BE INVESTIGATED.

FY82 PROGRAM DISTRIBUTION COMMODITY/SERVICE

	ARMY	NAVY	AIR FORCE	TOTAL
AIRCRAFT	13.0	0	33.9	46.9
MISSILES	.9	1.9	5.2	8.0
SHIPS	0	3.1	0	3.1
AMMUNITION	6.2	0	.6	6.8
WEAPONS	14.9	0	0	14.9
LAND VEHICLE	20.3	0	0	20.3
SUPPORT EQUIPMENT	0	0	0	0
TOTAL	55.3	5.0	39.7	100.0

THIS CHART PORTRAYS THE PROGRAM DISTRIBUTION BY COMMODITY AND SERVICE. BECAUSE OF THE LARGE INCREASE IN THE ARMY'S PROGRAM, ITS SHARE OF THE METALS PROGRAM HAS INCREASED BY OVER 20 PERCENTAGE POINTS. THIS INCREASE HAS BEEN LARGELY DUE TO THE SUBSTANTIAL INCREASE IN THE FUNDS ALLOCATED FOR LAND VEHICLES AND A MODEST INCREASE IN THE FUNDS ALLOCATED FOR HELICOPTERS. THE INCREASE IN LAND VEHICLES HAS MOVED ITS RANKING FROM FIFTH A YEAR AGO TO SECOND THIS YEAR. AIRCRAFT REMAINS FIRST AND BASICALLY AT THE SAME PERCENTAGE AS LAST YEAR.

FY82 PROGRAM DISTRIBUTION
TECHNOLOGY/SERVICE

	ARMY	NAVY	AIR FORCE	TOTAL
FORGING	6.2	0	2.1	8.3
CASTING	9.8	0	5.3	15.1
POWDER METALLURGY	3.9	0	10.6	14.5
ROLLING/EXTRUSION	0	0	.8	.8
METAL REMOVAL	13.1	0	5.1	18.2
JOINING	4.1	3.1	7.0	14.2
SURFACE TREATMENT	8.0	0	1.8	9.8
FORMING	1.1	1.9	3.1	6.1
OTHER	9.1	0	3.9	13.0
TOTAL	55.3	5.0	39.7	100.0

THE PROGRAM DISTRIBUTION BY TECHNOLOGY AND SERVICE SHOWS THAT WHILE THERE HAVE BEEN SMALL SHIFTS IN MOST OF THE TECHNOLOGIES WHEN COMPARED TO LAST YEAR, FORMING AND OTHER TECHNOLOGIES ARE THE ONLY TWO THAT HAVE CHANGED CONSIDERABLY. FORMING HAS BEEN CUT IN HALF WHILE THE OTHER TECHNOLOGIES, WHICH CONSIST OF PRIMARILY STRUCTURAL CERAMICS PROCESSING, HAS TRIPLED.

FY82 PROGRAM DISTRIBUTION
COMMODITY/TECHNOLOGY

	AIRCRAFT	MISSILES	SHIPS	WEAPONS	AMMUNITION	LAND VEHICLES	SUPPORT EQUIPMENT	TOTAL
FORGING	1.4	.7	0	1.5	2.2	2.5	0	8.3
CASTING	3.8	5.4	0	2.2	0	3.7	0	15.1
POWDER METALLURGY	11.1	0	0	.9	1.9	.6	0	14.5
ROLLING/EXTRUSION	.8	0	0	0	0	0	0	.8
METAL REMOVAL	6.5	0	0	7.2	0	4.5	0	18.2
JOINING	7.5	0	3.1	0	.8	2.8	0	14.2
SURFACE TREATMENT	2.1	0	0	2.9	.6	4.2	0	9.8
FORMING	4.0	1.9	0	.2	0	0	0	6.1
OTHER	9.7	0	0	0	1.3	2.0	0	13.0
TOTAL	46.9	8.0	3.1	14.9	6.8	20.3	0	100.0

THIS CHART SHOWS THE PROGRAM DISTRIBUTION BY COMMODITY AND TECHNOLOGY. WHILE THERE HAVE BEEN MANY CHANGES IN THE PERCENTAGES OVER LAST YEAR, THERE ARE NO MAJOR CHANGES EXCEPT AS YOU MIGHT EXPECT IN THE LAND VEHICLES. BECAUSE OF THE LARGE INCREASE IN THE FUNDS SUPPORTING THIS AREA, MOST OF THE PROCESS PERCENTAGES HAVE INCREASED SIGNIFICANTLY.

FY82 PROGRAM DISTRIBUTION

TECHNOLOGY/MATERIAL

	ALUMINUM	STEEL	TITANIUM	SUPERALLOY	OTHER	STRUCTURE CERAMICS	TOTAL
FORGING	0	5.6	0	2.7	0	0	8.3
CASTING	.9	5.4	2.0	6.0	.8	0	15.1
POWDER METALLURGY	3.5	3.4	1.7	5.9	0	0	14.5
ROLLING/EXTRUSION	0	0	0	.8	0	0	.8
METAL REMOVAL	2.3	11.8	1.9	2.2	0	0	18.2
JOINING	0	6.7	0	7.5	0	0	14.2
SURFACE TREATMENT	.3	7.4	0	.6	1.5	0	9.8
FORMING	2.1	.2	3.8	0	0	0	6.1
OTHER	0	0	0	3.9	1.3	7.8	13.0
TOTAL	9.1	40.5	9.4	29.6	3.6	7.8	100.0

THE PROGRAM DISTRIBUTION BY TECHNOLOGY AND MATERIAL SHOWS A LARGE PORTION OF THE PROGRAM DEALS WITH PROCESSING OF STEELS AND THAT A LARGE PORTION OF THE STEEL EFFORT IS CONCERNED WITH METAL REMOVAL. IT IS ALSO INTERESTING TO NOTE THE HIGH PROPORTION BEING DEVOTED TO THE PROCESSING OF SUPERALLOYS. THIS REFLECTS THE HIGH PROPORTION OF WORK FOR TURBINE ENGINES. IT IS ALSO INTERESTING TO NOTE THE RELATIVELY HIGH PERCENTAGE OF WORK INDICATED FOR STRUCTURAL CERAMICS PROCESSING. THE ARMY HAS TAKEN THE LEAD IN ESTABLISHING THIS TECHNOLOGY.

METALS MANUFACTURING TECHNOLOGY

A CHALLENGE IN THE 80'S?

●●●●●

I HAVE ATTEMPTED TO GIVE YOU AN IDEA OF WHAT I SEE AS THE MAJOR THRUSTS IN METALS MANUFACTURING TECHNOLOGY IN THE EIGHTIES. THEY DEAL WITH EXISTING OR ANTICIPATED PROBLEMS AND THEIR SOLUTION THROUGH SUCCESSFULLY APPLIED MANUFACTURING TECHNOLOGY. HOWEVER, I AM ALSO SURE THAT OTHER PROBLEMS WILL ALSO APPEAR IN THE EIGHTIES WHICH MAY ALTER THESE THRUSTS. WHATEVER THE FUTURE HOLDS, IT APPEARS CERTAIN THAT WE WILL BE ADEQUATELY CHALLENGED IN THE COMING DECADE TO PROVIDE THE NECESSARY METALS MANUFACTURING TECHNOLOGY THAT WILL ENSURE A MORE PRODUCTIVE AND RESPONSIVE INDUSTRIAL BASE.

ENERGY EFFICIENT PROCESSING

- INCLUDE ENERGY IN OUR COST DRIVER ANALYSES
- IMPROVE EXISTING PROCESSES
- ESTABLISH NEW PROCESSES

IN THE METALS AREA, ENERGY EFFICIENT PROCESSING HAS NOT YET DRAWN MUCH ATTENTION IN THE SERVICES PROGRAMS. THERE HAVE BEEN PROJECTS WHERE ENERGY CONSERVATION HAS BEEN THE PRIMARY BENEFIT SUCH AS THOSE AIMED AT REDUCING SOAK TIMES IN HEAT TREATING OUR CANNON TUBES AND REDUCING THE TEMPERATURE AT WHICH THE FORGING OF OUR LARGE CALIBRE PROJECTILES TAKES PLACE. BUT THERE HAS NOT BEEN A MAJOR CONCERTED EFFORT TO IDENTIFY ENERGY COSTS ASSOCIATED WITH MANUFACTURING OUR COMPONENTS. WHILE I RECOGNIZE THE DIFFICULTY IN TRYING TO SEGREGATE ENERGY COSTS SINCE THEY ARE OFTEN OBSCURRED IN OVERHEAD RATES AND MATERIALS COSTS, IT MAY PROVE WORTHWHILE TO INCLUDE ENERGY AS AN ELEMENT IN OUR COST DRIVER ANALYSES. THROUGH THIS TYPE OF ANALYSIS, WE COULD BEGIN TO FOCUS OUR ATTENTION ON ENERGY EFFICIENT PROCESSING WHICH COULD LEAD TO IMPROVEMENTS FOR EXISTING PROCESSES AND MAYBE TO ESTABLISHING NEW PROCESSES. AS ENERGY COSTS RISE, WE WILL BE FORCED INTO MORE ADEQUATELY ADDRESSING THEM.

CRITICAL FACTORS IN AUTOMATION

- UNIT PROCESSES
  - SENSORS
  - MODELS
- MANUFACTURING SYSTEMS
  - CONFIGURATIONS AND CAPABILITIES
  - EFFECTIVE USE AND MAINTAINABILITY

THE CRITICAL FACTORS THAT WILL LEAD TO AUTOMATED PROCESS CONTROL ARE SENSORS AND MODELS. THE INFORMATION PROCESSING CAPABILITY IS AVAILABLE TODAY. IN GENERAL, WHAT IS MISSING ARE SENSORS CAPABLE OF STANDING UP TO THE RIGORS OF THE PRODUCTION ENVIRONMENT AND THE MATHEMATICAL RELATIONSHIPS BETWEEN THE PROCESSING VARIABLES AND THE QUALITY OF THE COMPONENT. THEREFORE, MUCH OF THE WORK IN THIS AREA WILL ADDRESS THESE PROBLEMS.

MANUFACTURING SYSTEMS ARE RELATIVELY NEW AND WE HAVE A LOT TO LEARN ABOUT THEM. WE NEED TO LEARN MORE ABOUT HOW TO BEST CONFIGURE THEM AND WHAT CAPABILITIES THEY SHOULD HAVE. ONCE THESE SYSTEMS ARE ESTABLISHED, WE MUST LEARN TO EFFECTIVELY USE AND MAINTAIN THEM.

AUTOMATED PROCESSING

- UNIT PROCESSES
  - WELDING
  - METAL REMOVAL
  - COATING
- MANUFACTURING SYSTEMS
  - MACHINING SYSTEMS
  - SHEET METAL CELLS
  - BLADE REPAIR CENTER
  - ENGINE REPAIR CENTER

AUTOMATED PROCESSING IS A THRUST WHICH IS ALREADY VERY EVIDENT WITH THE METALS PROGRAM. IT IS OCCURRING AT TWO LEVELS - AT THE UNIT PROCESS LEVEL AND AT THE MANUFACURING SYSTEMS LEVEL. THE TREND AT THE UNIT PROCESS LEVEL IS TOWARD AUTOMATED PROCESS CONTROL. COMPUTERS WILL BE APPLIED TO ALL PROCESSES WHOSE PARAMETERS ARE CONTROLLABLE AND HAVE SIGNIFICANT IMPACT ON THE QUALITY OF THE COMPONENT AS IT IS BEING PRODUCED. EXAMPLES OF SUCH PROCESSES WHICH ARE ALREADY WITHIN THE SERVICES PROGRAMS ARE WELDING, METAL REMOVAL AND COATING PROCESSES. THE CONCEPT OF GROUPING MACHINES TO FORM A MANUFACTURING SYSTEM THAT WILL PERFORM MAJOR PROCESSING FUNCTIONS ON A SPECIFIC CLASS OF COMPONENTS WILL BE GETTING A LOT MORE ATTENTION. THIS TREND IS ALSO EVIDENT WITHIN THE METALS PROGRAM IN THE FORM OF FLEXIBLE MACHINING SYSTEMS, SHEET METAL MANUFACTURING CELLS, BLADE REPAIR CENTERS AND ENGINE REPAIR CENTERS.

TAILORED MATERIALS PROCESSING

- CONTROLLED MICROSTRUCTURE
  - THERMAL MECHANICAL WORKING
  - CONTROLLED SOLIDIFICATION
  - PHEOCASTING
  - RAPID SOLIDIFICATION TECHNOLOGY
- FABRICATION PROCESSES FOR NEW MATERIALS
  - CONSOLIDATION
  - FORMING AND CUTTING

THE CONCEPT OF TAILORING MATERIALS FOR MONOLITHIC METALLIC STRUCTURES CONSISTS OF CONTROLLING ITS MICROSTRUCTURE TO OBTAIN THE DESIRED PROPERTIES WHERE THEY ARE NEEDED. PROCESSES THAT HAVE THEIR ROOTS IN THERMAL MECHANICAL WORKING AND CONTROLLED SOLIDIFICATION HAVE BEEN AND WILL CONTINUE TO BE FUNDED BY THE SERVICES. AUSROLLING OF GEARS AND CASTING OF MONOCRYSTAL BLADES ARE GOOD EXAMPLES OF THESE TYPES OF PROCESSES. RHEOCASTING AND RAPID SOLIDIFICATION TECHNOLOGY HOLD PROMISE FOR THE FUTURE. BOTH TECHNOLOGIES OFFER THE ABILITY TO PRODUCE METALS WITH UNIQUE MICROSTRUCTURES AND PROPERTIES. RHEOCASTING - A PROCESS WHICH GIVES GREATER FREEDOM IN CREATING PARTICULATE FILLED COMPOSITE MATERIALS - CAN BE USED TO GENERATE NEW ENGINEERING MATERIALS FOR APPLICATIONS SUCH AS WEAR SURFACES. RHEOCAST MATERIAL ALSO OFFERS POTENTIAL PROCESSING BENEFITS AS WELL. THE DEFINITION OF RAPID SOLIDIFICATION TECHNOLOGY IS DEPENDENT UPON ONE'S INTERPRETATION OF WHAT CONSTITUTES RAPID SOLIDIFICATION. CONSEQUENTLY, ITS DEFINITION VARIES WITH THE INDIVIDUAL. THE DEFINITION IS NOT REALLY IMPORTANT. WHAT IS IMPORTANT, IS THAT HIGHER COOLING RATES ALLOW HIGHER LEVELS OF ALLOYING ELEMENTS TO BE OBTAINED IN THE BASE MATERIALS AND THEREFORE HAS LED TO THE INTRODUCTION OF NEW ALLOYS HAVING IMPROVED PROPERTIES FOR CERTAIN APPLICATIONS. AN EXAMPLE OF THIS IS THE ALUMINUM POWDER METALLURGY ALLOY CT91 WHICH CONTAINS HIGHER PERCENTAGES OF COBALT THAN CAN BE OBTAINED IN INGOT METALLURGY. THIS ALLOY OFFERS GREATER STRESS COROSION RESISTANCE AND IMPROVED NOTCH FATIGUE STRENGTH. EMERGENCE OF THESE NEW ALLOYS FROM RESEARCH AND DEVELOPMENT WILL CREATE THE NEED TO ESTABLISH PRODUCTION PROCESSES WHICH WILL YIELD THE REQUIRED QUALITY AND QUANTITY OF THESE ALLOYS.

WITH THE INTRODUCTION OF THESE NEW MATERIALS AND OTHERS SUCH AS CERAMICS AND INTERMETALLICS, ONE'S ATTENTION MUST ALSO FOCUS ON THE FABRICATION PROCESSES. WE MUST BE ABLE TO FABRICATE RELIABLE COMPONENTS IN A PRODUCTION ENVIRONMENT. SINCE MANY OF THESE NEW MATERIALS WILL BE PRODUCED AS POWDERS, HEAVY EMPHASIS ON CONSOLIDATION PROCESSES TO PRODUCE MILL PRODUCT FORMS AND DESCRETE COMPONENTS WILL CONTINUE. EMPHASIS WILL ALSO BE PLACED ON FORMING OR SHAPING AND CUTTING TECHNOLOGIES FOR THESE MATERIALS. JOINING TECHNOLOGY WILL ALSO BE CRITICAL NOT ONLY IN TERMS OF JOINING THESE MATERIALS TO THEMSELVES BUT ALSO IN TERMS OF INTEGRATING THESE MATERIALS WITH OTHER MATERIALS WITHIN THE PRODUCT. PROVIDING HIGH EFFICIENCY JOINING TECHNIQUES FOR MATERIAL COMBINATIONS SUCH AS CERAMICS AND METALS, AND COMPOSITES AND METALS WILL BE THE KEY TO INCREASING THE DESIGNERS FLEXIBILITY AND GREATER TAILORING OF THE MATERIALS IN OUR PRODUCTS.

THE INTRODUCTION OF NEW MATERIALS AND PROCESSES ALSO BRINGS WITH IT THE NEED FOR ADEQUATE INSPECTION AND QUALITY CONTROL PROCEDURES. WE NEED TO ESTABLISH THESE TECHNOLOGIES AS NEW MATERIALS ARE BEING DEVELOPED AND INTRODUCED INTO PRODUCTION. WITHOUT ADEQUATE QUALITY ASSURANCE PROCEDURES, THESE NEW MATERIALS WILL NOT BE INCORPORATED INTO OUR PRODUCTS.

CRITICAL AND STRATEGIC MATERIALS PROCESSING

CONSERVATION

- RECYCLING AND RECLAIMING
- NET SHAPE
- ALTERNATE MATERIALS

INCREASED CAPACITY

- MODERNIZATION
- ALTERNATE PROCESSES

CRITICAL AND STRATEGIC MATERIALS PROCESSING EFFORTS WILL BE CONCERNED WITH MAKING MORE EFFICIENT USE OF THESE MATERIALS OR CONSERVING THEM AND INCREASING OUR CAPACITY TO PROVIDE THEM. ONE METHOD OF CONSERVING THESE MATERIALS IS THROUGH RECYCLING AND RECLAIMING. WATERVLIET ARSENAL HAS BEEN INVESTIGATING HOW TO USE SPENT GUN TUBES AS PREFORMS FOR ROTARY FORGING NEW GUN TUBES. THE AIR FORCE HAS PURSED THE REJUVENATION OF BLADES AND DISKS THROUGH THE USE OF HOT ISOSTATIC PRESSING. ONE CAN EXPECT TO SEE MORE EFFORTS ALONG THESE LINES. NET SHAPE PROCESSING ALSO LEADS TO CONSERVATION. ALTHOUGH ALL THREE SERVICES HAVE PURSUED THIS TECHNOLOGY DURING THE SEVENTIES, THE NEED FOR CONSERVATION WILL SUSTAIN THIS DRIVE INTO THE EIGHTIES. DEVELOPING NEW ALLOYS WHICH USE LESS OF THE CRITICAL AND STRATEGIC ELEMENTS IS THE PROVINCE OF RESEARCH AND DEVELOPMENT. BUT ONCE THESE ALLOYS HAVE BEEN DEVELOPED, ESTABLISHING THE PROCESSES FOR MAKING THEM IN THE QUANTITY AND QUALITY REQUIRED WILL BE THE PURVIEW OF MANUFACTURING TECHNOLOGY.

OUR CAPACITY TO PRODUCE CERTAIN PRODUCT FORMS HAS BEEN OUT STRIPPED BY THE DEMAND FOR THEM. CONSEQUENTLY, YOU WILL SEE MORE EFFORTS TO EXPAND THE INDUSTRIAL BASE THROUGH IMPROVED MANUFACTURING TECHNOLOGY TO BE USED IN MODERNIZING AND EXPANDING THIS CAPACITY AS WELL AS ESTABLISHING ALTERNATE PROCESSES FOR OBTAINING THESE PRODUCT FORMS.

METALS MANUFACTURING TECHNOLOGY THRUSTS IN THE 80'S

- CRITICAL AND STRATEGIC MATERIALS PROCESSING
- TAILORED MATERIALS PROCESSING
- AUTOMATED PROCESSING
- ENERGY EFFICIENT PROCESSING

THE FIRST THRUST DEALS WITH PROCESSING OF CRITICAL AND STRATEGIC MATERIALS. COSTS OF SOME OF THESE MATERIALS HAVE ESCALATED AT DRAMATIC RATES. SPOT SHORTAGES HAVE OCCURRED. THERE IS CONCERN THAT WE ARE TOO DEPENDENT UPON FOREIGN SOURCES FOR SOME OF THESE MATERIALS. MANUFACTURING TECHNOLOGY, WHILE NOT THE TOTAL ANSWER TO THIS PROBLEM, WILL PLAY A MAJOR ROLE IN HELPING TO MINIMIZE ITS IMPACT. THE CONCEPT OF TAILORING MATERIALS TO SPECIFIC APPLICATIONS IS NOT NEW. ONE OF THE JOBS OF THE DESIGNER HAS ALWAYS BEEN TO SELECT THE RIGHT MATERIALS FOR A GIVEN JOB. BUT THE DESIGNER HAS BEEN LIMITED BY THE PROBLEM OF MATERIAL INCAPABILITIES AND THE PROBLEM OF INADEQUATE PROCESSING TECHNOLOGIES IN MAKING WHAT MIGHT BE CALLED THE "IDEAL MATERIALS SELECTION." MANUFACTURING TECHNOLOGY IN THE 80'S WILL PROVIDE THE DESIGNER WITH GREATER MATERIALS SELECTABILITY BY PROVIDING PROCESSES WHICH PRODUCE NEW MATERIALS WITH UNIQUE PROPERTIES AND WHICH ALLOW MORE VARIED MATERIALS TO BE USED IN OUR PRODUCTS. ANOTHER THRUST IN THE EIGHTIES WILL BE TOWARDS MORE AUTOMATED PROCESSING. AS THE COST OF COMPUTERS AND MICROPROCESSORS HAS DECREASED, THE DRIVE TOWARD APPLYING THEM TO THE OPTIMAL CONTROL OF METALS PROCESSING HAS INCREASED. THIS TREND IS EVIDENT TODAY AND WILL CONTINUE TO GROW IN THE 80'S. LASTLY, I SEE THE SERVICES PAYING MORE ATTENTION TO THE ENERGY USED IN PROCESSING METALS. WITH ENERGY COSTS INCREASING AS THEY HAVE AND WITH THE SUPPLIES OF CERTAIN ENERGY SOURCES BECOMING MORE TENUOUS, THE NEED TO CONSERVE THIS RESOURCE THROUGH IMPROVED MANUFACTURING TECHNOLOGY BECOMES GREATER. NOW LETS EXAMINE THE KINDS OF EFFORTS WHICH WILL BE MADE IN EACH OF THESE THRUSTS.

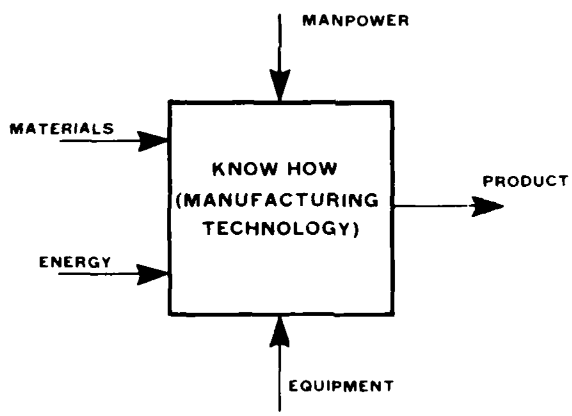
METALS TECHNOLOGY THRUSTS SHOULD STRIVE TO

- ENSURE ADEQUATE RESOURCES
- EFFICIENTLY USE OUR RESOURCES
- PROVIDE ADEQUATE KNOW HOW

Consequently, the thrusts of DOD's Metals Manufacturing Technology Program should strive to ensure that adequate resources exist; that these resources are efficiently used and that adequate know-how is provided to produce our products in a timely and cost-effective manner. The thrusts in Metals Manufacturing Technology in the eighties, that I envision, do strive to fulfil these needs.

MANUFACTURING — WHAT IS IT?

COMBINING OF RESOURCES TO PRODUCE A SPECIFIC PRODUCT



To me, manufacturing can be defined as the combining of resources to produce a specific product. Manufacturing Technology, then, is the knowledge required to combine these resources to yield the desired product. DOD's interest in manufacturing technology extends only to its affects on the products that we buy. DOD undertakes Manufacturing Technology efforts to ensure that our products have the desired performance; are available when we need them; and are available at a cost we can afford. Our products are becoming more and more sophisticated. This increasing sophistication requires better materials, tighter tolerances and increased geometric complexity. These demands create the need for improved manufacturing technology so that these products can be produced. The high cost of our products has also made it imperative that we learn how to more efficiently use our resources. Some of the resources used in manufacturing our products have become limited and projections of future supplies of these and other resources also show potential limitations. These limitations create the need for improved manufacturing technology to enable timely delivery of our products.

METALS MANUFACTURING TECHNOLOGY IN THE EIGHTIES

ANSWERING THE QUESTION

- RECENT HISTORY
- TECHNOLOGY OPPORTUNITIES
- TECHNOLOGY NEEDS

NOW LET ME TURN YOUR ATTENTION TOWARD THE FUTURE - THE FUTURE OF METALS MANUFACTURING TECHNOLOGY. IN ANSWERING THE QUESTION OF WHAT KINDS OF PROJECTS WILL BE FUNDED DURING THE EIGHTIES IN THE METALS AREA, WE NEED TO EXAMINE RECENT HISTORY TO IDENTIFY TRENDS THAT WILL BE EXTRAPOLATED INTO FUTURE; FUTURE TECHNOLOGY OPPORTUNITIES THAT MIGHT BE EVIDENT IN THE RESEARCH AND DEVELOPMENT AREA; AND THE TECHNOLOGY NEEDS WHICH MUST BE ADDRESSED FOR THE FUTURE. I HAVE CONSIDERED THESE FACTORS AND THEY ARE REFLECTED IN THE TRUSTS I HAVE IDENTIFIED. BUT I WOULD LIKE TO BEGIN ANSWERING THE QUESTION BY EXAMINING WHAT MANUFACTURING IS AND WHAT SOME OF ITS NEEDS ARE AND WILL BE IN THE FUTURE.

NEW TASKS

JOINT EFFORTS

- AUTOMATED CHEMICAL SOLUTION MONITORING

AS A RESULT OF THIS YEAR'S SUBCOMMITTEE MEETING, WE IDENTIFIED ONLY ONE NEW TASK FOR THIS YEAR. IT DEALS WITH AUTOMATED CHEMICAL SOLUTION MONITORING. THE ARMY AND AIR FORCE HAVE PROGRAMS IN THIS AREA AND WILL EXPLORE THE POSSIBILITY OF JOINTLY FUNDING THIS EFFORT.

WORKSHOPS AND SEMINARS

- MINI-SYMPOSIUM
- LASER MANUFACTURING TECHNOLOGY WORKSHOP
- PROTECTIVE COATINGS WORKSHOP

THE SUBCOMMITTEE HAD ALSO PLANNED TO HOST THREE WORKSHOPS AND SEMINARS. THE MINI-SYMPOSIUM WILL BE GIVEN ON WEDNESDAY. IT HIGHLIGHTS SOME OF OUR JOINTLY FUNDED EFFORTS. I INVITE YOU TO ATTEND WHAT I THINK WILL BE AN INFORMATIVE AND WORTHWHILE SESSION. THE TWO PLANNED WORKSHOPS WERE NOT HELD. WE EXPERIENCED DIFFICULTY IN GETTING PEOPLE TOGETHER TO PLAN AND EXECUTE THEM BECAUSE OF THEIR PRESSING WORK-LOADS AND THEIR DIFFICULTY IN OBTAINING TRAVEL FUNDS. WE HOPE TO HOLD THEM IN THE COMING YEAR.

ACCOMPLISHMENTS

- JOINT EFFORTS FORMED
  - PREMIUM SUPERALLOY CASTINGS
  - SMALL ARMS WEAPONS TECHNOLOGY
- JOINT EFFORTS STILL BEING NEGOTIATED
  - MONOCRYSTAL BLADES
  - AUTOMATION OF CONVENTIONAL WELDING PROCESSES
  - METAL REMOVAL

During the past year, the subcommittee has been responsible for forming two joint efforts. Last year, I reported that the Navy and Air Force had formed a joint effort to establish the technology for producing premium superalloy castings. This year, the Army has joined the Navy and Air Force in pursuing this technology. The other joint effort was formed between the Army and Air Force for establishing small arms weapons technology. This effort supports the establishment of technology which will be used in modernizing .50 calibre to 40mm small arms barrel production. Since much of the equipment used to make these barrels is government owned, the Army and the Air Force are currently negotiating a jointly funded follow-on equipment replacement program. This joint program illustrates the point I made earlier concerning cooperative technology modernization efforts. It was not the particular technologies being investigated in this project which led to the cooperative effort but, rather, the common need for small arms barrels by the Army and Air Force.

Some of the tasks we began this year are still in progress. The Navy and Air Force had programs for establishing manufacturing technology for monocrystal blades. Because of the uncertainty associated with the Navy program, this joint effort could not be formed. However, the Army has now expressed interest in joining the Air Force program. The details are currently being negotiated.

The next two tasks have been in progress for over a year and while at this time it does not appear that either task will result in jointly funded efforts, a considerable exchange of information and coordination has taken place. The Army is initiating an FY81 project for automation of conventional welding processes with a great deal of input from the other two services. We also recognize that there are other government agencies, particularly the Commerce Department and NASA, who are also pursuing this technology. We are, therefore, tentatively planning to host a Government/Industry Workshop in this area. The purpose of this workshop would be to display the various government agencies programs, identify potential overlap and solicit industry input to these programs.

The Metal Removal Area is dominated by the Army and Air Force. In March of this year, the Army hosted a meeting at Watervliet Arsenal. The purpose of this meeting was primarily to coordinate the metal removal efforts within the Army. But in recognition of the Air Force's role in this technology, they were asked and did participate in this meeting. This exchance proved fruitful and the need for further exchanges of information was identified. The Army and Navy have also participated in the Air Forces' Machine Tool Task Force whose results were presented to industry and government personnel last week. Continued coordination will be required as the services begin implementing some of the recommendations of that effort.

MUNITIONS SUBCOMMITTEE OVERVIEW

by

MR. ROBERT MESUK

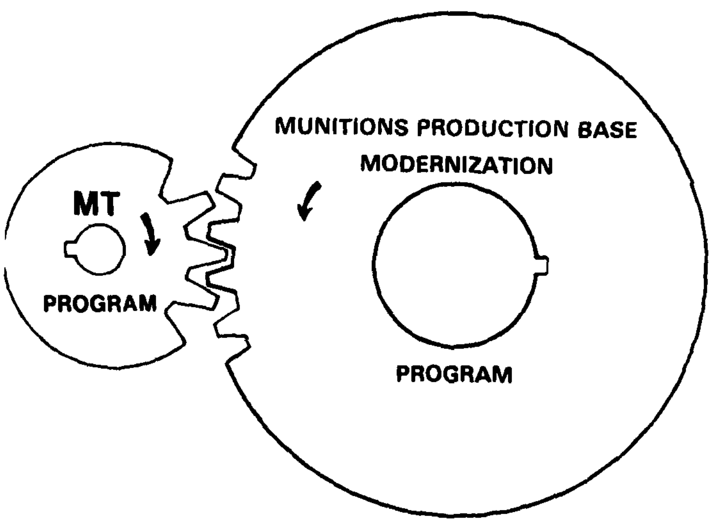
OUTLINE

- INTRODUCTION
- MUNITIONS PRODUCTION BASE
- MUNITIONS MT PROGRAM FY70 - 80
- FY81 & 82 MT PROGRAMS/THRUSTS
- MUNITIONS SUBCOMMITTEE RESPONSIBILITIES & ORGANIZATION
- MUNITIONS SUBCOMMITTEE FY80 ACCOMPLISHMENTS
- FUTURE ACTIONS
- MUNITIONS MINI - SYMPOSIUM

INTRODUCTION

- MTAG MUNITIONS SUBCOMMITTEE IS UNIQUE
- INVOLVES FULL SPECTRUM OF TECHNOLOGY
- REPRESENTATION ON OTHER MTAG SUBCOMMITTEES
- ENHANCE INDUSTRIAL READINESS
  - MODERNIZATION OF DOD MUNITIONS PRODUCTION BASE

TECHNOLOGY DRIVES MUNITIONS FACILITIES



MUNITIONS PRODUCTION BASE

INDUSTRY FACILITIES

- METAL PARTS
- COMPONENTS

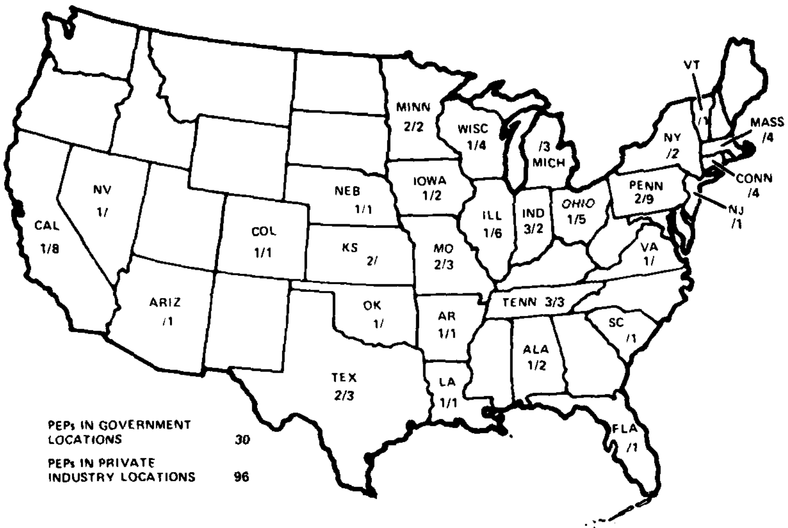
CONTRACTOR OPERATED FACILITIES

- LOAD, ASSEMBLE & PACK
- PROPELLANTS & EXPLOSIVES

GOVERNMENT OPERATED FACILITIES

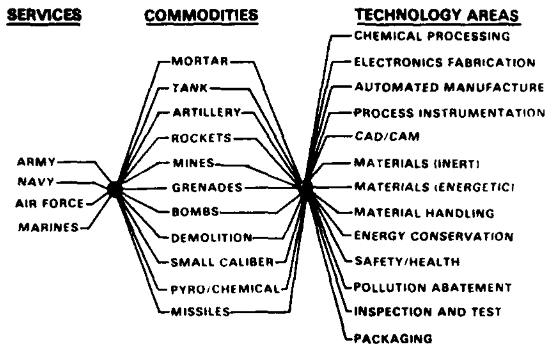
- CHEMICAL MUNITIONS

PEP LOCATIONS

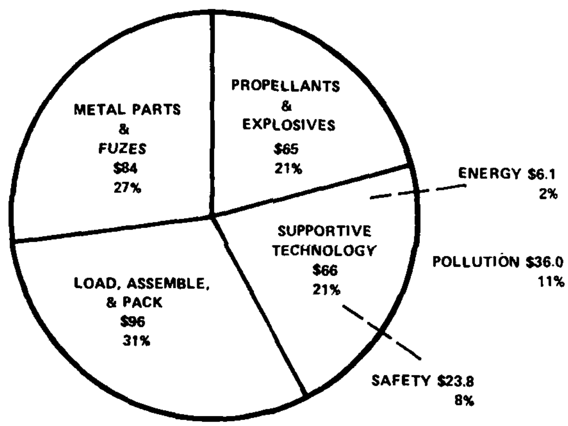


DOD CONVENTIONAL AMMUNITION PRODUCTION BASE
GOVERNMENT OWNED FACILITY LOCATIONS

MUNITIONS
SCOPE OF MT ACTIVITIES

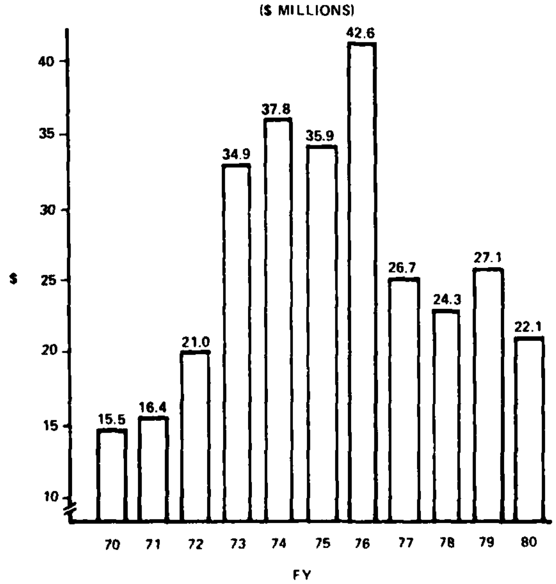


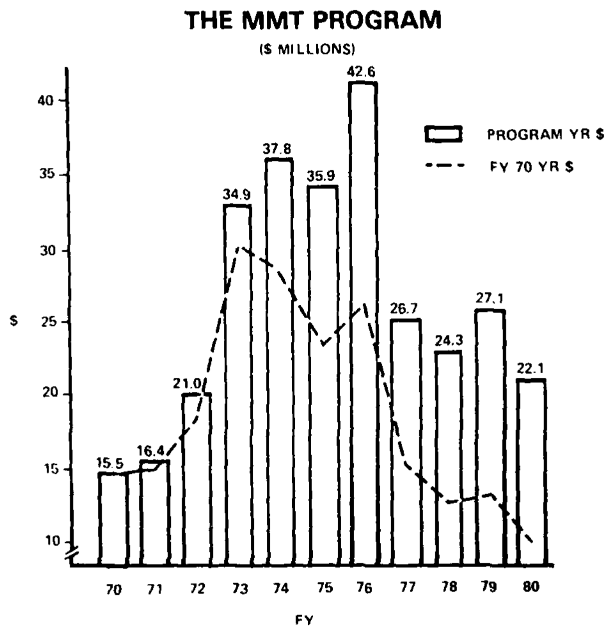
MANUFACTURING TECHNOLOGY PROGRAM
FY70-80 TOTAL $310 MILLION



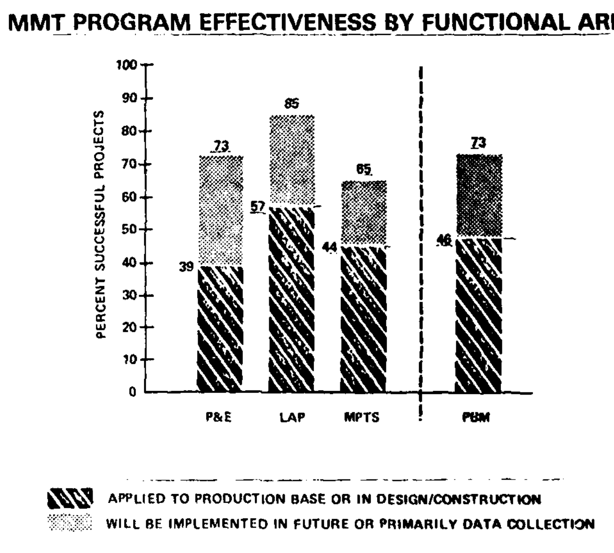
THE MMT PROGRAM

($ MILLIONS)





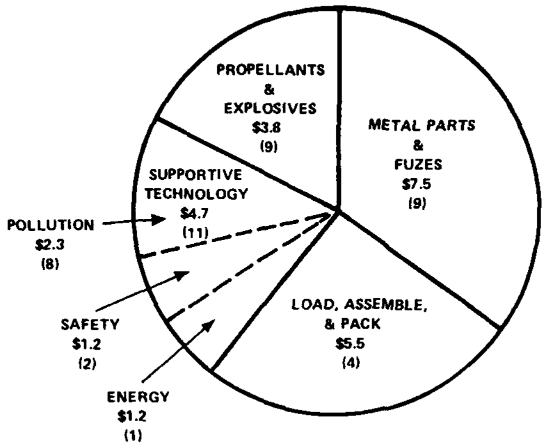
THE MMT PROGRAM
($ MILLIONS)
PROGRAM YR $
FY 70 YR $
$
FY
15.5
16.4
21.0
34.9
37.8
35.9
42.6
26.7
24.3
27.1
22.1
70 71 72 73 74 75 76 77 78 79 80



MMT PROGRAM EFFECTIVENESS BY FUNCTIONAL AREA
PERCENT SUCCESSFUL PROJECTS
73
39
85
57
65
44
73
46
P&E
LAP
MPTS
PBM
APPLIED TO PRODUCTION BASE OR IN DESIGN/CONSTRUCTION
WILL BE IMPLEMENTED IN FUTURE OR PRIMARILY DATA COLLECTION

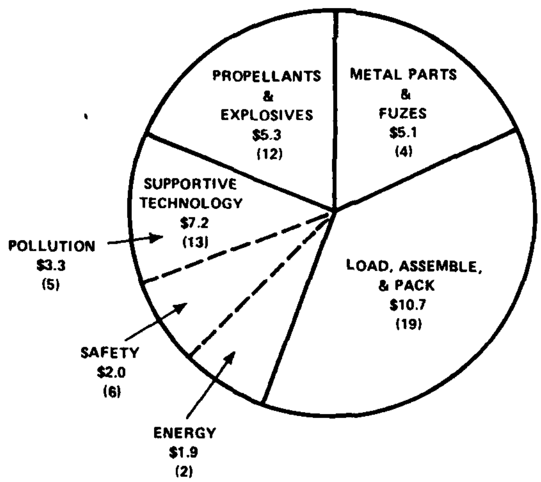
MANUFACTURING TECHNOLOGY PROGRAM
FY81 BUDGET

$21.5 MILLION
(33 PROJECTS)



MANUFACTURING TECHNOLOGY PROGRAM
FY82 BUDGET

$28.3 MILLION
(48 PROJECTS)



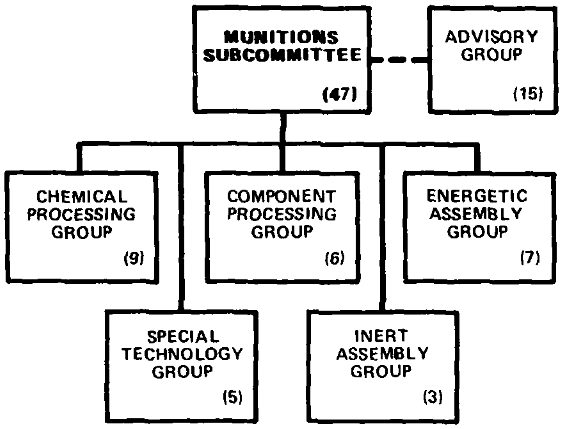
MAJOR THRUSTS
MUNITIONS MT PROGRAM

- PRODUCTIVITY
- COST REDUCTION
- NEW PROCESS DEVELOPMENT
- SAFETY
- ENERGY CONSERVATION
- POLLUTION ABATEMENT
- QUALITY
- READINESS

SUBCOMMITTEE RESPONSIBILITIES

- ASSESS & COORDINATE PROPOSED MT PROJECTS FOR:
  - COMPATIBILITY WITH DOD MT PROGRAM OBJECTIVES
  - DUPLICATION OF EFFORT
  - JOINT FUNDING
- IDENTIFY & PROPOSE SOLUTIONS TO ANTICIPATED PRODUCTION PROBLEMS
- RECOMMENDED AREAS OF IMPLEMENTATION & PROVIDE TECHNOLOGY TRANSFER FOR COMPLETED PROJECTS
- MAINTAIN KNOWLEDGE OF CURRENT STATE-OF-THE-ART PRODUCTION PRACTICES
- INTERACT WITH INDUSTRY TO FOSTER INDUSTRY AS A USEFUL RESOURCE FOR PROGRAM PLANNING, COORDINATION & IMPLEMENTATION

MUNITIONS SUBCOMMITTEE ORGANIZATION



MUNITIONS SUBCOMMITTEE SPECIALIZED TECHNICAL GROUPS

CHEMICAL PROCESSING

- PRIMARILY CONCERNED WITH ALL TYPES OF PROPELLANT & EXPLOSIVE MANUFACTURE. IT ALSO INCLUDES PYROTECHNICS & SPECIALIZED CHEMICAL COMPOSITIONS

COMPONENT PROCESSING

- THIS GROUP IS INVOLVED WITH UNIT COMPONENT PROCESSES FOR PRODUCTION OF SHELL BODIES, CARTRIDGE CASES, ROCKET FINS, & OTHER METAL & NON-METAL PARTS

ENERGETIC ASSEMBLY

- ENCOMPASSED HERE ARE ALL THE PROCESSES THAT INVOLVE AN ASSY WHICH INCLUDES AN ENERGETIC MATERIAL SUCH AS AN EXPLOSIVE OR PROPELLANT. LOAD ASSEMBLE & PACK (LAP) OF END ITEMS IS THE PRIMARY EXAMPLE OF THIS AREA

INERT ASSEMBLY

- THIS GROUPING INCLUDES ANY ASSEMBLY OPERATION, INTERMEDIATE OR FINAL, THAT DOES NOT INCLUDE ENERGETIC MATERIALS AS A PRIMARY COMPONENT. FUZES, INERT TYPE MUNITIONS & SUBASSEMBLIES ARE TYPICAL ITEM EXAMPLES

SUPPORTIVE TECHNOLOGY

- CONCERN OF THIS GROUP IS THE SPECIAL PROCESS AREAS SUCH AS POLLUTION ABATEMENT, SAFETY, HEALTH & ENERGY

MTAG MUNITIONS SUB-COMMITTEE
FY80 ACCOMPLISHMENTS

23 APRIL 80 CONFERENCE

- TRI-SERVICE REVIEW OF FY81 MT PROGRAM
- ARMY FIVE YEAR MT PLAN
- IBEA IMPLEMENTATION & EFFECTIVENESS REPORTING SYSTEM
- TECHNOLOGY DEMONSTRATION – MELT POUR & CONTROLLED COOLING PILOT PLANT

24 JULY 80 CONFERENCE

- REVIEWED DOD STATEMENT OF MT PRINCIPLES
- TRI-SERVICE REVIEW OF FY81/82 MT PROGRAM
- SELECTED FY80 TECH PAPERS/SUBMITTED ABSTRACTS
- TECHNOLOGY DEMONSTRATION – DRYING OF LOW DENSITY BALL PROPELLANT

30 SEPTEMBER 80 CONFERENCE

- DRY RUN TECH PAPERS
- DEVELOP FUTURE SUB-COMMITTEE PLANS

MTAG MUNITIONS SUB-COMMITTEE
CY80 MM&T PROJECT DEMONSTRATIONS

DATE	PROJECT TITLE	LOCATION
FEB	AUTO PRODUCTION EQUIPMENT FOR ASSY OF M692 ADAM MINE	LOUISIANA AAP
MAY	CONTINUOUS PROPELLANT DRYING, SALT COATING & GLAZING	BADGER AAP
MAY	SMOKE MIX FACILITY	PINE BLUFF ARSENAL
JUN-OCT	SEPARATION OF FINE EXPLOSIVES FROM SPENT ACID AND/OR WATER SLURRIES	HOLSTON AAP
JUN-DEC	BALL PROPELLANT PILOT PLANT STUDIES	BADGER AAP

MTAG MUNITIONS SUB-COMMITTEE
CY80 MM&T PROJECT DEMONSTRATIONS (CONT'D)

DATE	PROJECT TITLE	LOCATION
SEP/OCT	ONE PIECE SKIN ROLLING MACHINE-FAE II	KURT MFG, MINNEAPOLIS, MINN
OCT	ACCEPTANCE OF SINGLE BASE PROPELLANT MADE BY THE CONTINUOUS AUTOMATED PROCESS	RADFORD AAP
OCT/NOV	90 PPM CONTINUOUS MOTION M42/M46 GRENADE/FUZE ASSEMBLY MACHINE	KANSAS AAP
NOV	PRODUCTION TECHNIQUE FOR IMPROVED WP 155MM XM825	ARRADCOM, EDGEWOOD, MD
NOV	DRYING OF LOW DENSITY BALL PROPELLANT	ARRADCOM, DOVER, NJ
NOV/DEC	EQUIPMENT TO LAP CENTER CORE PROPELLANT CHARGES	CRANE AAP

FUTURE ACTIONS

- CONTINUE SUBCOMMITTEE EFFORTS
- INTEGRATE DOD MT PRINCIPLES
  - PROGRAM PLANNING
  - PROGRAM MANAGEMENT
- ENHANCE COORDINATION WITH INDUSTRY
- IMPROVE IMPLEMENTATION & TECHNOLOGY TRANSFER

MUNITIONS MINI-SYMPOSIUM

COMPONENT PROCESSING

- ONE PIECE SKIN/DIE CAST TAILCONE FOR FAE II
- MANTECH PLANNING/PROGRAM FOR 120MM AMMUNITION
- SIMULATION OF PRODUCT THROUGHPUT FOR PROJECTILE METAL PARTS PRODUCTION LINE

CHEMICAL PROCESSING

- SEPARATION OF FINE EXPLOSIVES FROM ACID OR WATER SLURRIES (BIRD-PANNEVIS FILTER)
- IMPROVE PRESENT PROCESS FOR MANUFACTURE OF HMX

ENERGETICS ASSEMBLY

- DEVELOPMENT OF PRODUCTION LOADING TECHNIQUES FOR THE 105MM HEAT-T M456A1 PROJECTILE
- AUTOMATIC HIGH SPEED ON LINE CARTRIDGE CASE INSPECTION SYSTEM

MUNITIONS MINI-SYMPOSIUM (CONT'D)

INERT ASSEMBLY

- COMPUTER AIDED REGULATION OF M577 FUZE TIMER
- HYDROSTATIC EXTRUSION OF FUZE PRECISION PINIONS

SPECIAL TECHNOLOGY

- UNIQUE FIRE SUPPRESSANT DELUGE SYSTEMS TO PREVENT EXPLOSIONS
- REMOVAL OF EXPLOSIVES FROM PROJECTILES USING CAVITATING FLUID JETS

OTHER (PRODUCT ASSURANCE)

- DYNAGUN BALLISTIC SIMULATOR
- APPLICATION OF RADAR TO BALLISTIC ACCEPTANCE TESTING OF AMMUNITION (ARBAT)

NON-METALS SUBCOMMITTEE OVERVIEW

by

MR. ROBERT TOMASHOT

The formal meetings held by the Subcommittee during the past year are listed in Figure 1. Highlight among these was a Subcommittee-Industry workshop held on the subject of in-process controls (Figure 2). The workshop was the result of past years tri-service project coordination wherein it was noted that all three services were conducting or planning projects that dealt with controlling key aspects as an integral part of the manufacturing process, such as during the fabrication of a composite component or an adhesive bonded structure, for improved quality or productivity. The workshop was highly beneficial and achieved our goal of assessing the state-of-art technology for this area and providing industry feedback on technology gaps and suggested future programs.

Through subcommittee contacts, we also were able to have Army and Navy participation in a ICAM/Composite workshop (Figure 3) which resulted in detailed roadmaps for introduction of the ICAM planning methodology into composites fabrication and the exploitation of the computer for reduction of indirect costs. With the assistance of Industry, required enabling technologies for composite component fabrication at the factor level were identified.

During coordination of the FY 82 program, the Subcommitee conducted a detailed review of forty-four planned projects with a total FY 82 dollar value of about twenty-five million. By subject and service, the breakout of this total amount is shown in Figure 4. Project activity on structural composites continues to be a major percentage of the nonmetals program because of the common tri-service interest in improved manufacturing techniques for helicopter, aircraft and missile components.

Figure 5 lists the major composite manufacturing thrusts representative of the combined efforts of the three services. The Army is continuing major efforts in filament winding to include both the spar and the airfoil of helicopter rotor blades by this technique, and also extend the filament winding process to higher temperature gearbox housing components by the use of polyimide matrix. Both the Army and Air Force have planned programs which will utilize the filament winding process for manufacture of cylindrical shapes representative of fuselage structure.

The Air Force plans to continue major efforts on automation of the laminating process, and extend automation and cost reduction efforts into the assembly area.

Each of the services plan to sponsor process improvement programs which address specific high cost or troublesome areas in composite fabrication, such as tooling, re-usable bagging, and non-autoclave curing.

The Navy is continuing their dominant role in metal matrix composites (Figure 6) with programs to provide the most suitable forms of material for composite fabrication, and demonstration of processes for fabrication of structural shapes with graphite-aluminum material.

In the carbon-carbon composites area (Figure 7), the major thrusts are on efforts which can assure the producibility and availability of strategic missile components. The process for manufacture of rocket nozzle billets is lengthy and expensive, and the major thrusts are establishing both lower cost and more reliable processes. Other thrusts in this area include the establishment of a satisfactory and reproducible process for manufacture of large area missile exit cones.

Figure 8 is included to show a listing of some of the accomplishments coming from the tri-service nonmetals program. Although the emphasis in subcommittee activity is on structuring the best possible future program, implementation of successful developments is most important to realize benefits of the Manufacturing Technology Program.

Short term benefits of subcommittee and MTAG coordination is indicated by Figure 9. During review of the planned FY 82 program, a significant number of projects and related project resources were identified which have the potential of more efficient management with continued coordination by subcommittee activities.

CY 80
SUBCOMMITTEE ACTIVITIES

APR 80	SUBCOMMITTEE MEETING	ALBUQUERQUE
MAY 80	NON-METALS PROCESSING WORKSHOP	ALBUQUERQUE
JULY 80	SUBCOMMITTEE MEETING	SIKORSKY, STRATFORD
SEPT 80	PROGRAM COORDINATION WITH AIA	GRUMMAN, MILLEDGEVILLE
OCT 80	NON-METALS MINI-SYMPOSIUM	BAL HARBOUR
FEB 81	TRI-SERVICE COMPOSITES MFG REVIEW	ORLANDO

TRI-SERVICE SYMPOSIUM

IN-PROCESS QUALITY CONTROL FOR NON-METALLIC MATERIALS

MTAG
NON-METALS

30 APRIL-1 MAY 1980

ALBUQUERQUE, NEW MEXICO

1990

1980

ICAM COMPOSITES WORKSHOP

January 9-10-11, 1980

Sheraton Dayton-Downtown
Dayton, Ohio

NON-METALS TECHNICAL-COST BREAKOUT
FY 82 ($K)

	ARMY	NAVY	AIR FORCE	TOTAL
ORGANIC COMPOSITES	7,025	270	4,450	11,745
METAL MATRIX COMPOSITES	1,250	0	300	1,550
CARBON-CARBON COMPOSITES	1,050	0	2,300	3,350
ELASTOMERS	1,648	1,490	400	3,538
LUBRICANTS	172	0	300	472
FIBERS	875	0	400	1,275
ADHESIVES	380	0	1,500	1,880
PLASTICS	492	0	400	892
	12,892	1,760	10,050	24,702

COMPOSITES MANUFACTURING THRUSTS

- FILAMENT WINDING
  - ROTOR BLADE, SPAR, AIRFOIL
  - POLYIMIDE MATRIX
- AUTOMATION
  - FABRICATION
  - ASSEMBLY
- CYLINDRICAL SHAPES
  - HELICOPTER STRUCTURE
  - FUSELAGE STRUCTURE
- PROCESS IMPROVEMENTS
  - TOOLING
  - BAGGING TECHNIQUES
  - NON-AUTOCLAVE

METAL MATRIX COMPOSITES

MANUFACTURING THRUSTS

- OPTIMUM PROCESSING CONDITIONS
  - REINFORCEMENT, MATRIX COMBINATIONS
- TOOLING FOR STRUCTURAL SHAPES
- COMPONENT MFG. FOR REPRODUCIBILITY, COST DATA

CARBON-CARBON COMPOSITES

MAJOR THRUSTS

- INDUSTRY CAPABILITY; PRODUCIBILITY
- REDUCED PRE-FORM, DENSIFICATION COSTS
- LOW COST, RANDOM FIBER NOZZLES
- LARGE AREA CONE STRUCTURES

NON-METALS MANUFACTURING HIGHLIGHT PROJECTS/ACCOMPLISHMENTS

ARMY	NAVY	AIR FORCE
LOW COST COMPOSITE ROCKET NOZZLE	LOW COST FOAMED RADOME	AIRCRAFT CANOPY MFG. PROCESS
HIGH VOLUME PRODUCTION TECHNIQUE FOR ROCKET MOTOR CASE	COMPOSITE MISSILE WING FABRICATION	ADHESIVE SEAL PROCESS FOR FUEL TANKS
COMPOSITE REAR FUSELAGE COMPONENT MANUFACTURE	METAL FACED COMPOSITE TOOLING	AUTOMATED COMPOSITES FABRICATION PROCESSES
COMPOSITE ENGINE INLET PARTICLE SEPARATOR		

SUBCOMMITTEE COORDINATION

PROJECT INFLUENCE

	VALUE ($K)
4 — POTENTIAL PROJECTS DELETED	1345
2 — JOINTLY FUNDED PROJECTS	1400
5 — POTENTIAL FOR JOINT FUNDING	5980

TRI-SERVICE SYMPOSIUM

IN-PROCESS
QUALITY CONTROL FOR
NON-METALLIC MATERIALS

30 APRIL-1MAY 1980

ALBUQUERQUE, NEW MEXICO

INFORMATION TRANSFER

MODERATOR - DR. LLOYD LEHN

Assistant for Manufacturing Technology
Office of the Under Secretary of Defense for Research and Engineering

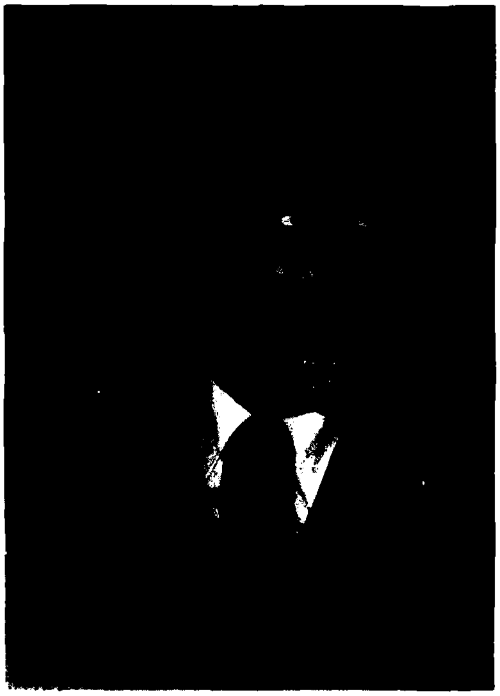
PRECEDING PAGE BLANK-NOT FILMED

CENTER ON UTILIZATION OF FEDERAL TECHNOLOGY

by

MS. MARGERY H. KING
Acting Director, COUFT

Presentation not available for publication



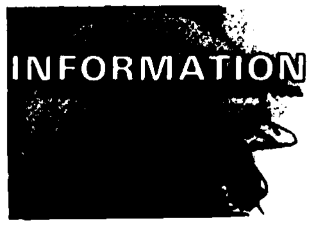
INFORMATION SERVICES AVAILABLE FROM DTIC

by

MR. PAUL KLINEFELTER

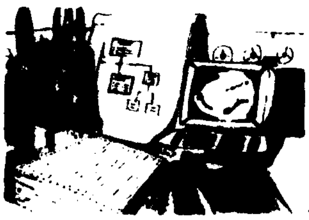
Deputy Director of Data Base Services
Defense Technical Information Center

Information: A Basic R&D Management Tool



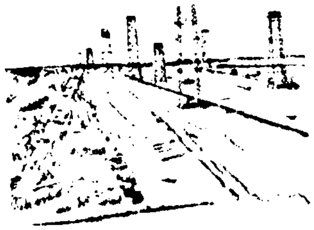
"USDRE is responsible for a highly diverse and widely deployed research, development, and acquisitions program of over $55 billion per year.

"Because research and development is essential to the nation's defense, efficient and effective management of resources is critical.



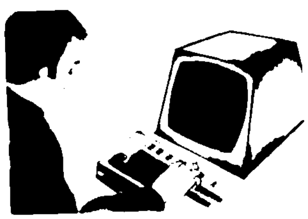
"A basic tool used in the management of these resources is information--information on past, current, and proposed technical projects...

"Which is used to preclude the duplication of work. For ex-ample...

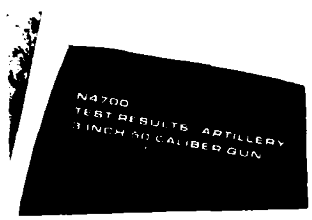


[illegible]

[illegible]

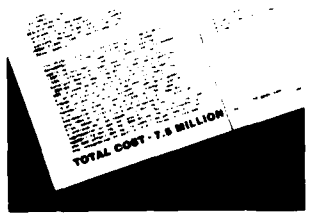


'Before undertaking the expensive test program, the Project Manager ordered a technical investigation search for previous test data on the specific weapon from the technical library.

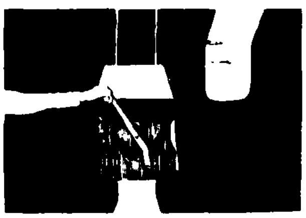


'A database search revealed that an earlier test had been performed on the same weapon.

The information already obtained from the earlier tests subsequently reduced the amount of additional testing required.

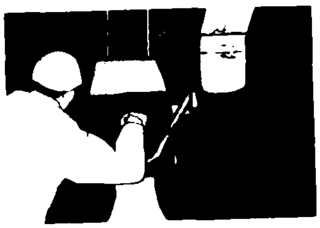


The [illegible] cost 7.5 million [illegible]



The new tests required to update the information in the technical report were conducted at a cost of less than $20,000.

Thus, the library search resulted in a substantial cost avoidance.

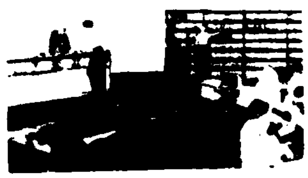


"This illustrates a key role the Defense Technical Information program can employ in DoD's R&D.

"The acquisition, reporting, and application of effective, productive information facilitates management of the R & D processes. It is to this end . . .

SCIENTIFIC AND TECHNICAL INFORMATION

"that Defense scientific and technical information programs are dedicated. A major element of this information program is to eliminate duplication of effort and resources by encouraging and expediting the exchange of information.



"The Defense Technical Information Center--DTIC--provides focus for technical information in DoD.

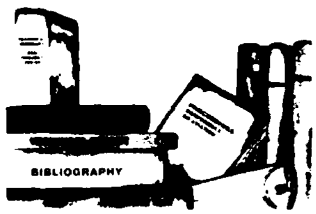
INPUT

DTIC

OUTPUT

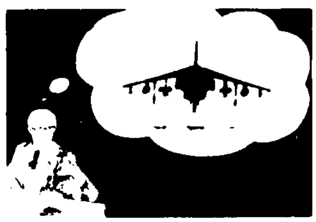
INFORMATION

DTIC is the contact point for information related to the DoD research, development, and acquisition effort. It provides a computer-based information service of planned, current, and completed DoD Research, Development, Test, and Evaluation activity.

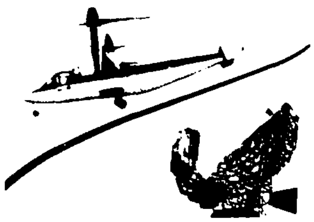


Information is available [illegible] about R&D progress [illegible] in the form [illegible] descriptions.

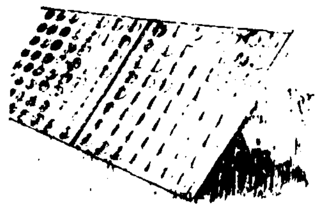
DoD directives require that each R&D project and work effort is documented in a standardized format including relevant information such as objective, approach, and conclusions. DTIC is the source for answers to such questions as . . .



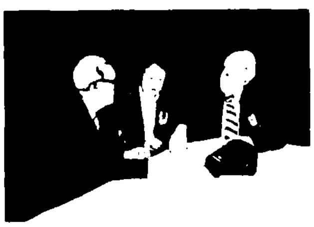
What previous work has been completed in my specific area of interest? . . .



What are the latest developments in such fields as high performance airborne systems? in target acquisition systems? . . .

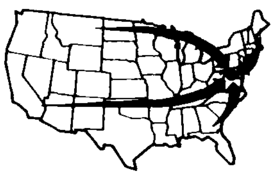


Is DoD sponsoring work in solar cell and solar panel research?



What is the best method for structuring and budgeting a 5-year technical management training program? . . .

The answers to these questions help program managers become aware of current scientific technical and managerial information—giving them the benefit of previous research and save them the time, cost, and possible embarrassment of duplicating work already [illegible]



"DTIC provides a point of contact for research, development, test, and evaluation information developed within DoD. DTIC also has established a nationwide on-line network that connects individual activities with the central databases. Analytical and special informational services are also provided.

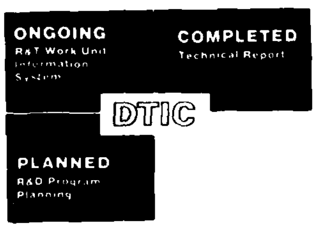
"DTIC serves DoD activities, DoD contractors, other agencies, and local government. Services also are available to participants in the DoD Potential Contractor Program--especially giving small businesses an opportunity to share state-of-the-art studies in areas of interest.

"Access to DTIC is simple--usually through the activity's technical library or direct to DTIC. Information can be requested from four databases--

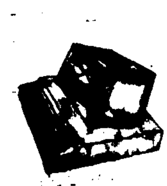
"The first of these, the R&D Pr gram Planning Data Base, contains descriptions of planned RDT&E projects. It is a source of management information at the project and task level.

"Descriptions of ongoing individual R&D efforts are described in the R&T Work Unit Information System Data Bank. These are technical summaries including information concerning . . .

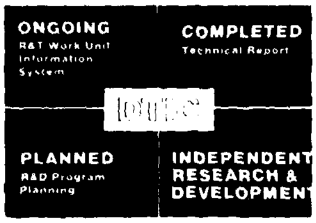
"what contract, grant, or in-house work is being done, where it is being carried out, when it is being done, how, at what costs, and who the sponsoring agency is.



"The results of completed and current DoD sponsored R&D efforts are included in DTIC's extensive collection of over one million technical reports. They are stored at DTIC in either microfilm or microfiche format.



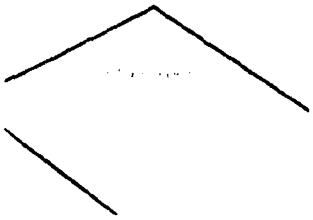
This technical literature collection represents billions of dollars in DoD research performed by leading government and industry activities facilities.



"A fourth DTIC database includes information about industry-funded *research and development.*

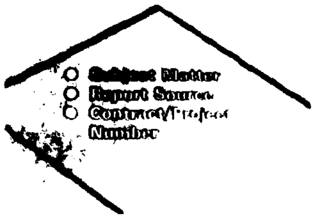
"Communications between DoD managers and scientists and their counterparts in industry are enhanced by this data base, which contains proprietary information on industry projects pursued *independently of DoD contracts.*

"Information in all four databases is stored in a DTIC computer located in Cameron Station, Alexandria, VA.

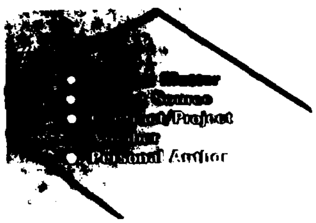


"Databases may be searched by subject matter . . .

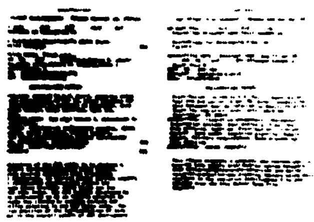
"corporate source or contributor . . .



"contract number or project . . .



"personal author, or a combination of many search elements.



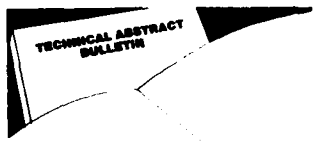
"Or--a listing of reports related to a project or in a specific subject area.

"Requests for DTIC searches or copies of documents can be made by mail, on-site terminal, or telephone. The requested printouts or copies of documents will be mailed to your registered address. Technical reports are distributed either as microforms or paper copy.

"whatever media format--microform, electronic, or paper--the information is custom selected and prepared upon request.

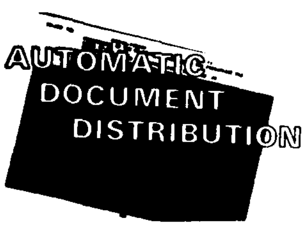
CLASSIFIED and LIMITED

"*In support of local* DoD activity technical libraries and information resources, DTIC provides a Technical Abstract Bulletin, or TAB, service. Every two weeks the TAB is published. It lists citations to classified or limited reports received by DTIC during the period. An annual index *also is available.*



Unclassified and Unlimited and NATIONAL TECHNICAL INFORMATION SERVICE

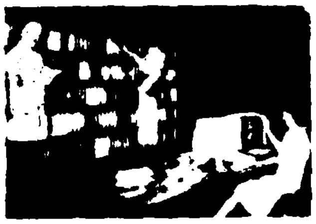
"Unclassified and unlimited technical report announcements are also distributed through the National Technical Information Service.



"Still another service to users is provided by the Automatic Document Distribution--ADD--Program. A subscription to ADD will provide microfiche copies of new <u>technical reports</u> *in a designated* subject *area* every two weeks. The ADD service anticipates expressed needs. An auziliary service is the ...

Current Awareness Bibliographies

"*Current Awareness Bibliography Program.* This customized automated information service is designed for recurring subject needs from the Technical Reports database. A subscription to this service provides an individualized bibliography: every two weeks the subscriber's subject interest profile is *matched against newly* acquired research results and the Technical Report database.



"Over 100 users of DTIC services receive real-time search response by [illegible] to the [illegible] Defense [illegible] system of terminals located in technical libraries and connected to the DTIC data bases.

"Any registered DTIC user can connect to the DTIC data bases via a terminal already installed. The advantage of such communication is that in addition to instant response, the original search can be refined to improve results.

"Database searches can lead to technical information resources <u>outside</u> of DTIC through DoD and contractor activities.

INFORMATION ANALYSIS CENTERS - IAC

"One such service is the DoD Information Analysis Centers--IAC's. There are over twenty DoD-sponsored IACs. Some are operated by the military services. And some are sponsored by the Defense Logistics Agency with contractor-operated IACs under the administrative control of DTIC.

METALS AND CERAMICS
NON-DESTRUCTIVE TESTING
Thermophysical and Electronic Properties
CHEMICAL PROPULSION
Reliability
COMMAND and CONTROL
and others

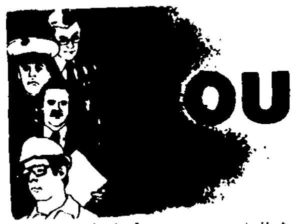
"These centers operate in critical R&D areas of needed expertise. Their mission is to collect, review, evaluate and disseminate authoritative technical information in a variety of media.

"*Another such contractor service is* the Government-Industry Data Exchange Program--GIDEP. This exchange has enabled DoD to save as much as . . .

"25 million dollars a year, simply by contractors using information in the DTIC data bank and referral systems.

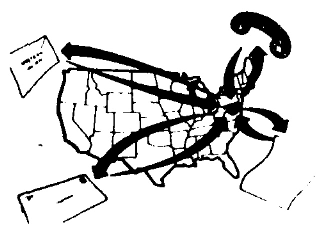
"No technical information program is more effective than the data contained. For that reason, it is *vital that all individuals responsible* for DoD RDT&E ensure that the results of their efforts are entered into the program.

"Sources and contributors of relevant technical information span the spectrum of the DoD management and scientific community, other government agencies, academic institutions, and foreign nations.



"As the principal source or contributor, your active support is needed if *you are engaged in the management of* RDT&E for the Department of Defense.

"Conscientious input to the formal technical information system of reports and data of any DoD-sponsored or co-sponsored research. . . planned research. . . ongoing research. . . or completed research--are required in an effective database needed . . .



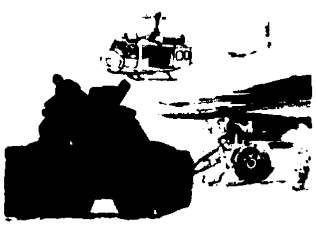
"to ensure the continuous exchange of information within the DoD community--and to assist in the prevention of duplication and waste.

"DTIC has an unparalleled record for security and control of access to the data entrusted.

"DTIC must rely on the diligence of the R&D managers to ensure that data bases are current and complete.

"Not every DTIC database user will be able to save 7.5 million dollars.

Some savings will be much less. But there is always the possibility that savings could be much more. But whatever the specific amount,



"Users of DTIC can be assured that they are taking an important step to avoid unnecessary work.

"The Defense Technical Information Center exists to serve the DoD RDT&E community in providing a basic R&D management tool--information.

For Further Information, Contact:

DEFENSE TECHNICAL INFORMATION CENTER

Cameron Station
Alexandria, Virginia
22314

(202) 274-7633
Autovon 28-47633

Produced by
DEFENSE TECHNICAL INFORMATION CENTER
Your Partner in R&D

DEFENSE LOGISTICS AGENCY
CAMERON STATION
ALEXANDRIA, VIRGINIA

ARMY MANUFACTURING TECHNOLOGY DATA BASE SYSTEM

by

MR. JOHN PETRONE

U.S. Army Industrial Base Engineering Activity

Good evening. As we all know, the role of information transfer within the technical community can be an important key to increased productivity. Enhancing the transfer of technical information and increasing the amount of this information are recommendations of studies that have been made at the highest levels of government. In fact, one of the main purposes of this annual MTAG Conference is to exchange technical information, and the growing attendance at these conferences attests to the desire and the need for this information.

You have heard briefings on technical information initiatives being planned at the department level; both outside DoD and at DoD. Narrowing the scope somewhat, I will talk on the operational information system that is in use for the Army's manufacturing methods and technology program.

CHART 1 (ARMY MMT PROGRAM)

As a frame of reference, this chart shows some statistics concerning the Army's MMT program. It is evident from the numbers that a substantial amount of technical work and information was, is, and will be generated within the program. It is the transfer of this information that is of interest at this meeting.

CHART 2 (INFORMATION RESOURCES)

Before discussing the transfer methods, it is well to identify the vehicles through which information can be made available. This chart depicts the two main resources, the MTMIS and recurring informational reports. Each will be discussed separately with emphasis on the MTMIS since in addition to being used independently, it is also used directly or indirectly in the publication of most of the recurring reports.

CHART 3 (MTMIS)

The Army's MMT information is centralized around the Manufacturing Technology Management Information System. Because of the ills that are attendant with automated management information systems, a very conservative approach was taken in developing the MTMIS. The actual development started in July 1976 and the system became operational in August 1978.

Some facts concerning the MTMIS are as follows: the system resides on CDC computers and obtains its power to have information sorted, ordered, and retrieved through the use of a generic data base management system called System 2000, a commercial package highly utilized in DoD. The small to medium size data base, containing 13,000,000 characters, was designed primarily to be used in a management role, vis a vis a library role. Specifically, the automated MTMIS was developed to aid in keeping track of an expanding program, the individual projects of which can span a period of 7 years. Because of the role for which the data base was designed, the content of the data base is not geared towards significant amounts of full text, but rather short key words or phrases. The textual fields that do exist are limited by design to 50 words or less. What type of data then can be provided from this MTMIS? That can best be explained by discussing the type of data that is maintained in it.

CHART 4 (DATA BASE CONTENTS)

The MTMIS contains project data obtained during all phases of its life cycle; planning, budgeting, execution, and implementation. This life cycle can extend to 7+ years.

The next series of charts will display the type of data captured during each of these phases along with some quantitative data which can give you a feel for the amount of data available.

CHART 5 (PLANNING DATA)

In addition to effort identification and future funding requirements, problem/solution statements and various descriptors are added during the planning phase of a project.

CHART 6 (BUDGETING DATA)

Upon submission of P-16's, additional data is added to a project's record. Further project identification, points of contact, and additional technical descriptors, such as process, MTAG category, and end item are input to the MTMIS at this time.

CHART 7 (EXECUTION DATA)

Milestone data, fiscal obligations data, contract information, and work summary information are added during the execution cycle. The technical report acknowledgement input (in lieu of tech report text) is one example of the data base being management oriented rather than library oriented.

CHART 8 (IMPLEMENTATION DATA)

After a project is completed, follow-up is made on an annual basis to determine the implementation status. Pertinent data of the type shown here is gathered and kept to aid in showing the benefits of the program.

That very briefly describes the type of data that is maintained in the MTMIS. (Detailed data descriptions are available upon request.) Obviously, anything maintained in it can be transferred out of it. As touched on earlier, the mechanism for this transfer is the use of an English-like Data Base Management System (DBMS) which, through simple English commands sorts, orders, and retrieves information which is qualified by the user.

CHART 9 (SYSTEM 2000 COMMANDS)

For those of you who are not acquainted with System 2000 or DBMS'S in general, this chart shows some typical English-like commands which might be used to retrieve information from the data base.

CHART 10 (MTMIS INFORMATION TRANSFER)

The utilization of this software to transfer ad hoc information from this MTMIS can take place in two ways; either directly or indirectly. Direct transfer involves personally accessing the data base. Hardware and software knowledges required normally make this advantageous only for the frequent user. More typically, access is of an indirect nature whereby a user's request is directed to IBEA personnel who in turn access the data base.

CHART 11 (MTMIS IMPROVEMENTS)

The last chart on the MTMIS explains some of the work being done for future improvements to the system. As mentioned early, the MTMIS was not developed as a textual, library type data base. It is doubtful whether its primary use will ever be in that area. However requests over the past two years have pointed out some areas where additional textual data might be beneficial. Work is being done to determine the effects of capturing and storing textual data (250 - 1,000 words) related to two data fields; work objective and scope of work.

Some preliminary work has been done to determine the desirability of moving the data base to an IBM mainframe in order to take advantage of the increased power that the software has on its IBM version. This work will continue and be implemented if it can satisfy demonstrated needs without burdening the system with cost ineffective overhead.

CHART 12 (RECURRING INFORMATIONAL REPORTS)

The other vehicle mentioned at the outset for transferring MT information was the recurring informational report. I will briefly discuss the contents and publication dates of the 10 recurring informational sources shown on this chart. Concerning distribution, the first seven reports, published by IBEA, have standard distribution lists, to include industry associations, and DTIC. No direct distribution is routinely made to industry. Normally, some extra copies of these documents are maintained at IBEA and provided to individuals who make specific requests for specific documents. Upon depletion of IBEA's extra copies, requestors are provided accession numbers and referred to DTIC.

The 8th and 9th report are available through subscription services and MMT technical reports are distributed by the commands executing the work and are available through NTIS.

CHART 13 (PROGRAM PLAN)

The MMT Program Plan is published annually, typically in September. In the future, this plan will be published in August as specified by the new regulation. This document lists the Army's MMT projects being planned. It covers 5 years, starting with the current FY and extending out 4 additional years. The plan just published covers FY 80-84. Included in the document is a project title, brief problem and solution statements, and proposed funding. Additionally, as a guide for industry, the appendices contain informational data on the Army's MMT program. It is collated by commodity command, and then by standardized category and component identifiers.

CHART 14 (EXECUTION REPORT)

This report is published twice a year; typically in March and September. It contains a listing of all the MMT projects under execution along with each project's fiscal status and summary of work accomplished during the past 6 months. Summary statistics and trends in the MMT program are contained in appendices.

CHART 15 (EFFECTIVENESS REPORT)

This report is published once a year, typically in October. It contains data summarizing the success

of implementation efforts taken on completed MMT efforts.

CHART 16 (SUMMARY REPORT)

This report, published twice a year in June and December, summarizes the technical results of completed MMT projects. The summaries are normally derived from the final technical reports, with results of approximately 100 completed projects being contained in each report.

CHART 17 (ACCOMPLISHMENTS BROCHURE)

This brochure is published once a year in August. It is a compilation of hard copies of viewgraphs which are used in briefings to describe the accomplishments of the MMT program. For each completed project, there is normally one chart containing a graphic representation of the project along with data extracted from the summary report.

CHART 18 (MT BULLETIN)

The MT Bulletin is the Army's "MMT Newspaper." It is published quarterly in April, July, October and January. It contains news features which are deemed to be of interest to the readers of the bulletin. It is also used to further disseminate MMT policies which have been staffed as well as technical information which has been generated from on-going or recently completed projects. Some of the sections of the bulletin include: "News & Notes," "Current Events," "Computer Aided Technology," "Recently Completed Projects," "Tech Notes," and "DoD & MTAG."

CHART 19 (T&I QUARTERLY)

The T&I Quarterly is similar to the bulletin, except its emphasis is more on the distribution of technical information. Also rather than encompassing the MT program as a whole, it is more narrowly concerned with test and inspection only. Distribution is directed to quality assurance personnel rather than MT points of contact. Some sections of the quarterly include: "DARCOM T&I News," "T&I Technology Transfer," "T&I Technical Report Publications," and "T&I Calendar Of Events." It is published in March, June, September, and December.

CHART 20 (MT JOURNAL)

The MT Journal is the Army's MMT magazine. It is published quarterly and can be obtained by subscription. Each journal is published around a central theme, and the technology of on-going or complete MMT work is discussed in the magazine. Some "Themes" of recent journals include: Achievements at AVRADCOM, Chip Removal Conference, Composites, Materials Testing and Product Assurance, Joining, and Electronics.

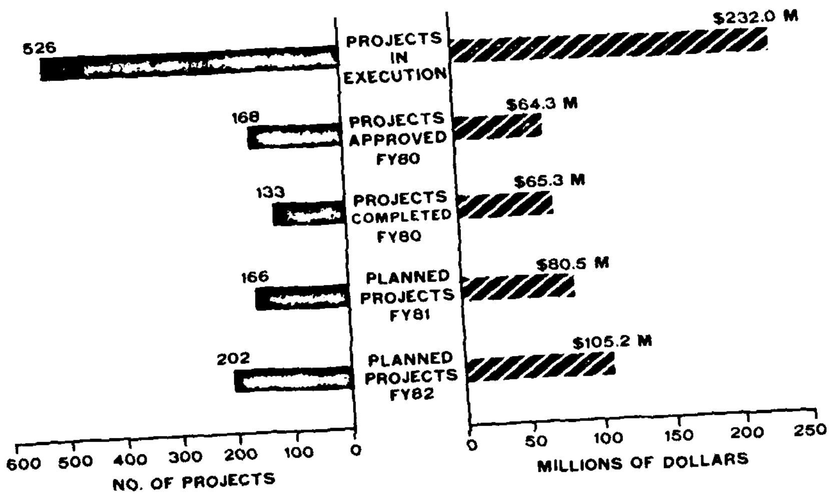
CHART 21 (NTIS NOTES)

This report is published by the Department of Commerce based on inputs from the Army, Navy, Air Force, NASA, Agriculture, etc. It summarizes manufacturing technical accomplishments from each of the above agencies and maintains for sale support packages which more fully describe the manufacturing process discussed in the note.

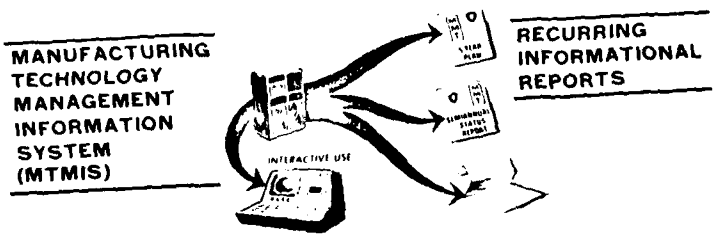
CHART 22 (TECHNICAL REPORT)

This is the report published by the organization which executed the project. It contains the total details of the work which was completed. It is distributed by the executing agency and is normally maintained as part of the support package by NTIS.

ARMY MMT PROGRAM



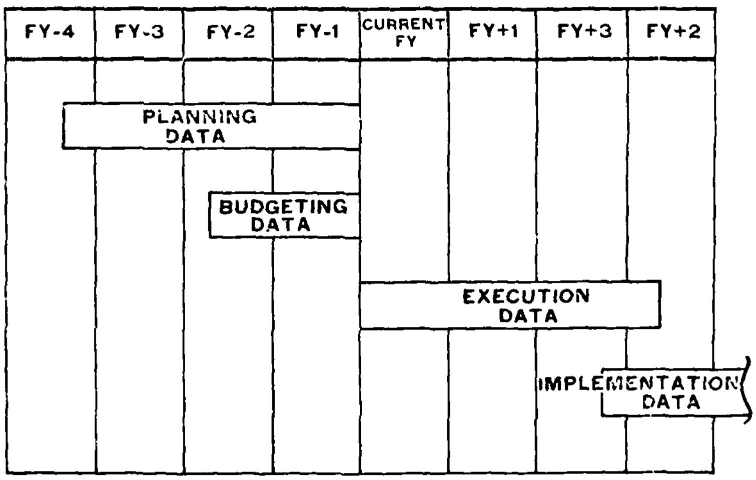
ARMY MT INFORMATION RESOURCES



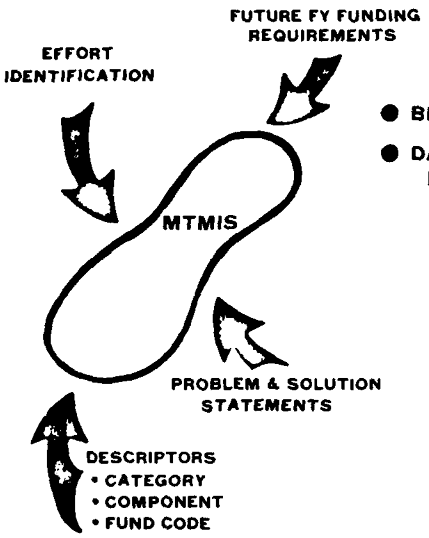
MANUFACTURING TECHNOLOGY MANAGEMENT INFORMATION SYSTEM (MTMIS)

- OPERATIONAL SINCE AUG 1978
- UTILIZES SYSTEM 2000 SOFTWARE
- RESIDES ON CDC 6000 SERIES COMPUTER
- CONTAINS 13,000,000 CHARACTERS
- DATA BASE DESIGNED & USED PRIMARILY IN A MANAGEMENT ROLE
  - HEAVILY KEY WORDED
  - LIMITED FULL TEXT

DATA BASE CONTENTS

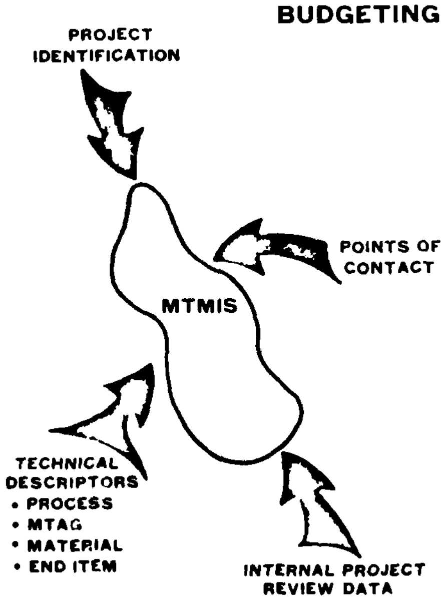


PLANNING DATA



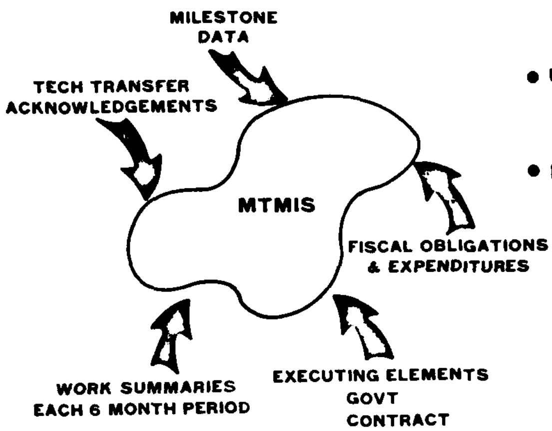
- BIANNUAL UPDATE
- DATA ON 3100 PLANNED WORK EFFORTS
  - COMMENCING WITH 1973 FIVE YEAR PLAN
  - INCL 727 EFFORTS IN THE 1980 PLAN
  - INCL 990 EFFORTS ULTIMATELY FUNDED

BUDGETING DATA



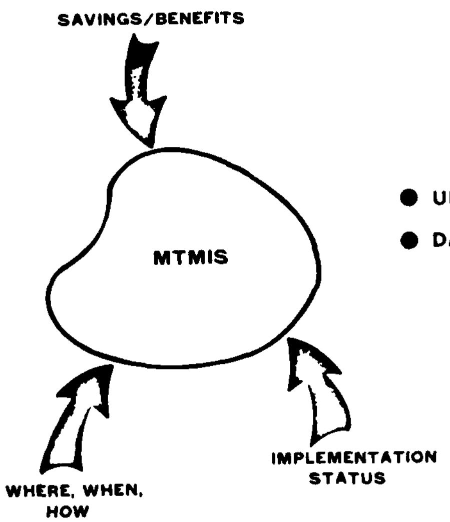
- UPDATED UPON P-16 SUBMISSION
- DATA ON 2900 PROJECT REQUESTS
  - COMMENCES WITH FY70 P-16'S
  - INCL 1600 PROJECTS ULTIMATELY FUNDED

EXECUTION DATA



- UPDATES
  - BIANNUAL
  - AS CHANGES OCCUR
- DATA ON 1600 PROJECTS
  - ALL APPROVED PROJECTS SINCE FY70
  - INCL 550 CURRENTLY ACTIVE PROJ

IMPLEMENTATION DATA



- UPDATED ANNUALLY
- DATA ON 600 WORK EFFORTS

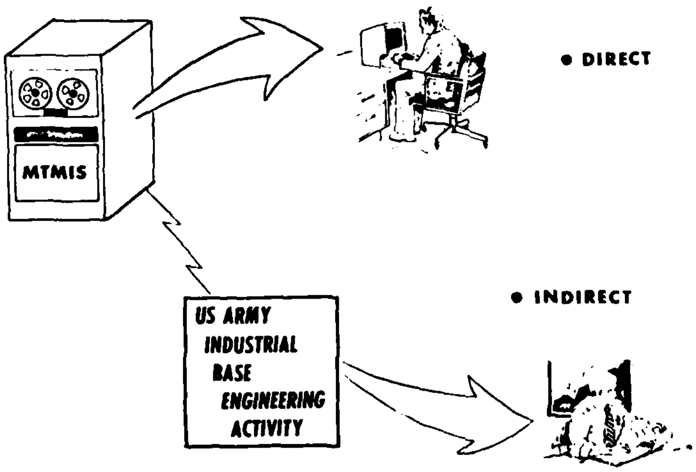
SYSTEM 2000 COMMANDS

- PRINT PROJ NO, PROBLEM, SOLUTION WHERE PROCESS EQ DRYING:
- PRINT PROJ NO, FINAL TECH REPORT NO, ACTION OFFICER, AUTOVON, ORDERED BY FINAL TECH REPORT DATE WHERE FINAL TECH REPORT NO EXISTS AND PROCESS EQ EXTRUSION:

OR EQUIVALENTLY,

- PR C280, C354, C430, C440, OB C355 WH C354 EXISTS AND C620 EQ EXTRUSION:

MTMIS INFORMATION TRANSFER



FUTURE MTMIS WORK

- ADDITIONAL TEXTUAL DATA
- MOVEMENT TO IBM MAINFRAME
- COORDINATION WITH DOD MT DATA BASE

RECURRING INFORMATIONAL REPORTS

- MMT PROGRAM PLAN
- MMT PROJECT EXECUTION REPORT
- MMT EFFECTIVENESS REPORT
- MMT ACCOMPLISHMENTS BROCHURE
- MMT SUMMARY REPORT
- MT BULLETIN
- TEST & INSPECTION QUARTERLY
- MT JOURNAL
- NTIS NOTES
- TECHNICAL REPORTS

U S ARMY

MATERIEL DEVELOPMENT AND READINESS COMMAND

MANUFACTURING METHODS & TECHNOLOGY

PROGRAM PLAN

CY 1980

DISTRIBUTION UNLIMITED
DOCUMENT FOR PUBLIC RELEASE

PREPARED BY SEPTEMBER 1980

MANUFACTURING TECHNOLOGY DIVISION
U S ARMY INDUSTRIAL BASE ENGINEERING ACTIVITY
ROCK ISLAND, ILLINOIS 61299

U.S. ARMY
MATERIEL DEVELOPMENT
AND READINESS COMMAND

MANUFACTURING
METHODS &
TECHNOLOGY

PROJECT EXECUTION REPORT

FIRST CY 80

PREPARED BY AUGUST 1980
USA INDUSTRIAL BASE ENGINEERING ACTIVITY
MANUFACTURING TECHNOLOGY DIVISION
ROCK ISLAND, ILLINOIS 61299

U.S. ARMY
MATERIEL DEVELOPMENT
AND READINESS COMMAND

MANUFACTURING
METHODS &
TECHNOLOGY

EFFECTIVENESS REPORT

1979

(RCS DRCMT-303)

PREPARED BY OCTOBER 1979

USA INDUSTRIAL BASE ENGINEERING ACTIVITY

MANUFACTURING TECHNOLOGY DIVISION

ROCK ISLAND, ILLINOIS 61299

U.S. ARMY
MATERIEL DEVELOPMENT
AND READINESS COMMAND

MANUFACTURING METHODS & TECHNOLOGY

PROJECT SUMMARY REPORTS

(RCS DRCMT-302)

PREPARED BY DECEMBER 1978

USA INDUSTRIAL BASE ENGINEERING ACTIVITY

MANUFACTURING TECHNOLOGY DIVISION
ROCK ISLAND, ILLINOIS 61299

U S ARMY
MATERIEL DEVELOPMENT AND READINESS COMMAND

PROGRAM ACCOMPLISHMENTS

MANUFACTURING
METHODS
&
TECHNOLOGY

PREPARED BY OCT 80

MANUFACTURING TECHNOLOGY DIVISION
U S ARMY INDUSTRIAL BASE ENGINEERING ACTIVITY
ROCK ISLAND, ILLINOIS 61299

US ARMY MANUFACTURING TECHNOLOGY BULLETIN

NUMBER 17, OCTOBER, 1980

WHAT'S NEWS –

PAGE

PUBLISHED BY THE

INDUSTRIAL BASE ENGINEERING ACTIVITY
MANUFACTURING TECHNOLOGY DIVISION

ROCK ISLAND, ILLINOIS 61299

DARCOM T&I

CHEMICAL
ELECTRONIC
MECHANICAL
NON DESTRUCTIVE TEST

DARCOM TESTING & INSPECTION QUARTERLY NO. 2

SEPTEMBER 1980

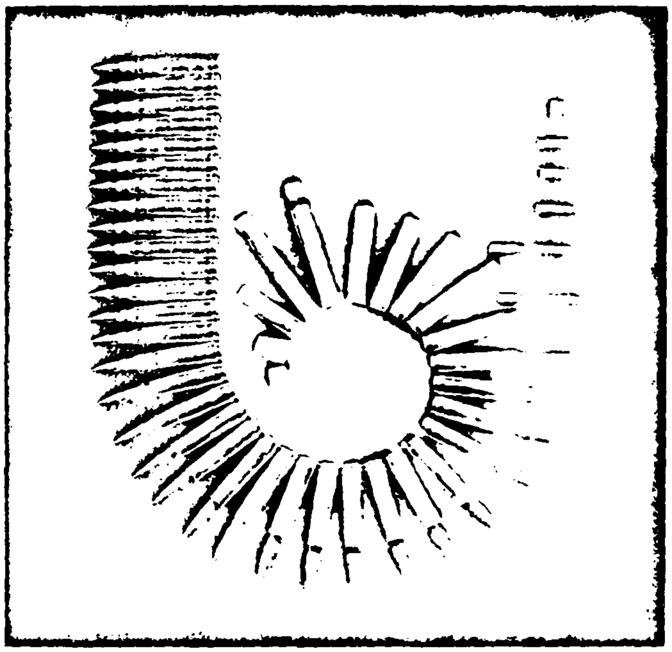
CONTENTS

PUBLISHED BY
US ARMY INDUSTRIAL BASE ENGINEERING ACTIVITY

US Army
ManTech Journal

Proven Tests in Time to Help

Volume 3/Number 2/1978



MTN-78/0745

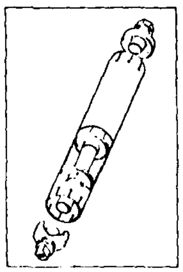
MANUFACTURING TECHNOLOGY NOTE

U.S. ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND

Office of Manufacturing Technology Alexandria Virginia

Economical Manufacture of Reliable Plastic Parts

Molding techniques and use of standard epoxy/glass tubing make ballistically tolerant components for helicopter rotor controls



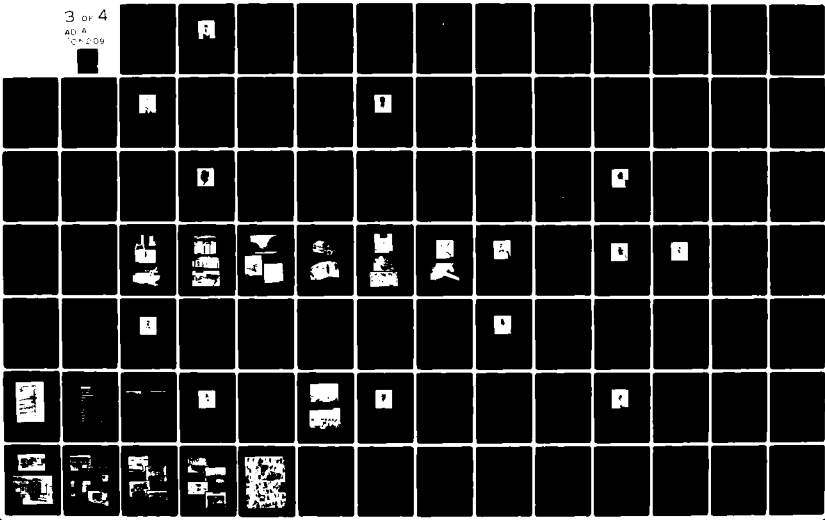
The **Connecting-Link Assembly** [illegible]

[illegible]

AD-A105 209 DEPARTMENT OF DEFENSE WASHINGTON DC F/G 13/8
PROCEEDINGS OF THE ANNUAL TRI-SERVICE MANUFACTURING TECHNOLOGY --ETC(U)
OCT 80

UNCLASSIFIED NL

3 OF 4
AD A
105209



4 JAN 1979

REPORT NO. HDC-43-78

EVALUATION OF PILOT MOLECULAR SIEVE FOR NO_x ABATEMENT ON AOP NITRIC ACID UNIT

CONTRACT NO. DAAA 09-73-C-0079

M.R. SMITH
HOLSTON DEFENSE CORPORATION
SUBSIDIARY OF EASTMAN KODAK COMPANY
KINGSPORT, TENNESSEE 37662

NOVEMBER, 1978

FINAL ENGINEERING REPORT

PREPARED FOR:
COMMANDER, ARRADCOM
SARPA-MT-C
DOVER, NEW JERSEY 07801

INFORMATION CAVEATS

- INFORMATION TRANSFER IS COSTLY
- INCREMENTAL BENEFITS DIFFICULT TO QUANTIFY
- THERE NEVER SEEMS TO BE ENOUGH INFORMATION AVAILABLE
- THE INFORMATION THAT IS AVAILABLE NEVER SEEMS TO BE EXACTLY WHAT IS WANTED
- ITS DIFFICULT TO SEPARATE USEFUL INFORMATION FROM NICE-TO-HAVE INFORMATION
- ITS EASIER TO WANT INFORMATION THAN TO PRECIPITATE ACTIONS BASED ON INFORMATION THAT YOU HAVE

NEED FOR A MANUFACTURING TECHNOLOGY INFORMATION ANALYSIS CENTER

by

MR. LOUIS A. GONZALEZ

Senior Data Analyst, General Electric - TEMPO

(1) Good Evening to all of you attending this Information Transfer session of MTAG '80. My name is Lou Gonzalez from General Electric -- TEMPO. The purpose of this briefing is to present a summary of the effort now underway in our organization to study the feasibility of establishing a DoD Manufacturing Technology Information Analysis Center. The study was sponsored by the Army Materials and Mechanics Research Center in Watertown and is now 90% completed. An interim report was submitted in August and a final report is scheduled to be delivered to AMMRC in early December.

(2) The purpose of the study was basically to determine the need and desirability of establishing a manufacturing technology IAC and to assess the scope of activities such a Center should undertake. The primary objective is to provide DoD and AMMRC with the information needed to decide if an MTIAC should be funded and, if needed and feasible, how such a Center should be implemented. This chart highlights the major tasks we undertook in the study.

(3) Our approach to the study, as indicated here, was to organize the data gathering, analytical and other activities into four major work areas: a prospective users survey, an existing systems and centers review and evaluation; an MTIAC model definition and analysis; and, finally, the development of a start-up strategy and implementation plan with appropriate funding levels.

(4) Early in the study we developed a framework for an idealized MTIAC model as shown in simple form here. Our intent was to represent and relate in a logical structure all the elements of a system for the dissemination of needed information to the MT user communities. The model was constructed during the course of the study by collecting and organizing data to fit into the logical elements -- such as potential users, inputs and outputs -- shown in the chart. After all the elements were defined, an analysis of the idealized model was made. This analysis included a consideration of influencing factors such as annual funding levels, management, appropriate scope, and operational constraints. From this analysis we were able to develop alternative Center concepts in terms of its functions and activities. A final Center concept was then selected. The balance of the briefing is organized to correspond to the model.

(5) One of the earliest determinations was that of the need for an MTIAC. We found, from the user survey, and other in-person and telephone interviews, that 90% of the potential users favored the formation of an MTIAC primarily for the reasons highlighted here. Desirability, based on broader issues such as improving productivity and enhancing innovation in industry, was equally favorable in our surveys. In summary, potential users felt that an MTIAC could serve as a viable technology transfer agent to produce and disseminate information tailored to their needs.

(6) At this point we will define the prospective users by way of highlighting the survey findings. About 370 responses were received out of a total of 700 potential users surveyed. The chart shows the percent of total responses for each user community. This includes the results of a questionnaire mailing, personal and telephone interviews and individual correspondence to key individuals. The survey response listed in the chart shows private industry (including DoD contractors and non-DoD manufacturing firms) totalling the greatest -- over 75%.

(7) The next chart shows the priority ranking of survey responses by predominant areas of interest. Of the total surveyed it appears that most potential users interests in all the user communities surveyed are in advanced manufacturing processes, followed closely by automated manufacturing, including robotics, and CAD/CAM. Interests were also expressed in advanced materials, but users, in general, feel that this area is adequately covered by their existing sources. Less than 10% of potential users expressed interests across the full spectrum of MT.

(8) The priority information needs expressed by potential users are shown in this next chart. Two of the three user communities shown expressed a strong need for information on past, on-going and planned MT projects that could be produced by a computerized data base. All user communities surveyed also expressed technical and bibliographic inquiry services as a priority need followed closely by state-of-the-art reviews of key MT areas and current awareness information by newsletter or other means.

It should be noted that we found the size of the potential user population to be more apparent than real. Many potential users in the private sector are involved in MT activities only some of the time. The majority of users, however, felt a need for a central source for MT information, particularly DoD contractors.

(9) We also reviewed and evaluated the existing system -- that is where and how potential users currently handle their MT information needs. The elements of this system are shown in this chart grouped under two networks. Information is transferred between the users and the two networks and among the elements of each network as shown. The figures in the information-oriented network represent the approximate number of significant MT data bases in each category.

As you can see, there is no means for the existing system to integrate DoD MT program

results and developments to give every type of user within the user communities an overview of total MT activities. The primary means of information transfer in this existing system is by informal communications, journals, conferences, and industry publications. The majority of activities in the system having some relation to MT information are concerned with serving the particular organization housing them.

(10) This chart highlights the Center's potential sources of information and the type of inputs they could most likely furnish the Center. Reports resulting from completed Military Services MT projects will represent the largest number of inputs to an MTIAC collection. The next largest number of inputs will be technical journal articles from professional and trade societies, followed by non-proprietary technical reports from private industry and non-DoD reports from other government sources. Other IACs can be expected to contribute a moderate amount of MT-related inputs primarily in the area of advanced materials processing. It should be noted that the technical area of materials has the greatest potential for coverage overlap with other centers and data bases.

We also determined that the most significant growth in the size of MT data base (currently estimated at between 30,000-50,000 documents) will result from technical reports produced by the DoD MT contracting program with industry and the products emanating from active MT programs and in large manufacturing firms.

(11) The existing system review provided us with an insight into the breadth and diversity of manufacturing technology as it applies to producing and maintaining DoD Materiel. It became obvious early in the study that to keep the technical scope of the Center within manageable dimensions a phased-development approach would be needed. It was felt that such an approach would decrease the risk of the Center expending resources outside of its capabilities during its formative period of development.

The phase-development approach is based on an emphasis in the near-term of a few selected MT areas such as the candidates outlined in this chart. The criteria for this near-term scope would be to initially focus on dissemination of completed MT project results (which, incidentally could help in quickly demonstrating its value as a technology transfer agent). Identifying areas of overlap and avoiding duplication of coverage with other DoD Centers would also be emphasized in the near-term. MT coverage would concentrate on pervasive areas that cut across the widest possible spectrum of DoD materiel and that are highly beneficial and cost effective within short turnaround.

(12) Our analysis of the DoD MT Program revealed more than 50 broad or generic areas of MT with about two dozen key areas. Future development of the Center can be focused on extending its near-term coverage to include on-going and planned MT projects and all generic and key MT areas, not covered elsewhere, that relate to the DoD MT program goals. This growth should also be designed to accomodate other users such as non-defense manufacturers, and to provide sophisticated computer-based on-line data exchange with other centers and data bases.

(13) Feasibility of an MTIAC was addressed in the study by a matching of funding and management requirements to corresponding activities and service levels. The division of funds, we felt, should be shared by the Military Services at 90% and the Office of Secretary of Defense (OSD) at 10%. This was deemed to be an equitable sharing based upon the extent of the benefits that each of these funding sources could derive from the Center.

Management and operations of the Centers primary functions were also determined to be as listed in the chart, with OSD shown as developing and maintaining a DoD MT projects data base with an on-line terminal link to the Center. Also indicated is the use by the contractor of the DTIC support system and data base for bibliographic data. Most of the other functions shown, with the exception of "conference sponsorship" and "EOP demonstrations," were evaluated as most feasible for management and operation by a contractor firm.

(14) Annual funding levels for the Center were next evaluated using three alternative activity service levels as noted in this chart. Estimated costs for the activities relevant to each primary function were determined for each service level. Critical IAC activities and those expressed as priority needs by potential users were emphasized, particularly in the baseline level. The activities and cost factors were then summarized and matched to the appropriate funding levels. The chart shows that the most sophisticated Center concept corresponding to annual funding of "over one million dollars" includes some labor-intensive activities in addition to all of the activities identified in the other two service levels. It is estimated that it would take an MTIAC about 5 to 6 years to achieve the service level for the sophisticated concept.

(15) Implementation of the Center was approached in terms of a start-up strategy and its near-term operations. Ten planning elements were considered as shown in the chart. Each element was examined with respect to a near-term and future emphasis. The start-up strategy was then developed to correspond to the near-term emphasis and the lowest feasible annual funding

level in keeping with a "phased-development" approach. The start-up strategy shown would allow an MTIAC to initially focus on developing the data bases and collection; designing publications, and emphasizing diffusion of completed DoD MT project results. Further, the Center could limit its in-depth expertise to a few key technology areas.

In its formative development years the Center could be expanded conservatively to encompass other MT key areas and could start providing data concerning on-going and planned MT projects, as well as manage the production of more publications and other products and services.

(16) We are currently completing our reviews and analyses related to other considerations and issues associated with establishment of an MTIAC before preparing the final report. This chart outlines the more important of these. For example, we are attempting to determine the relationship between an MTIAC and the recently-formed Cooperative Technology Program in the Department of Commerce. We also want to examine the impact of limited coverage on the usage and users of the Center and the need for a classification scheme to structure the diverse field of MT for purposes of cataloging and retrieval. We are looking into the most appropriate means for private industrial firms to contribute to an MTIAC the non-proprietary data emanating from the MT programs. We are developing recommendations for information control and safeguards for an MTIAC. We are also reviewing some associated MT issues that should be considered by a Center when planning its expanded scope.

Discussions of these issues are beyond the intent of this briefing and we plan to discuss them in appropriate detail in the final report.

Finally, after assessing the need for the Center, defining it in conceptual terms and determining its feasibility, we looked at its future role in the overall transfer of MT. We found that the Center could become an important link in the network between producers and users of MT on the factory floor. We also found that as the Center matures it could become a crucial part of a highly developed set of MT delivery systems serving government and private sector users at all levels of requirement and sophistication.

Thank you for your attention. This concludes our briefing.

TEMPO

PLANNING STUDY TO ESTABLISH DOD MANUFACTURING TECHNOLOGY INFORMATION ANALYSIS CENTER (MTIAC)

OCTOBER 1980

Presented at

TWELFTH ANNUAL TRI-SERVICE
MANUFACTURING TECHNOLOGY CONFERERENCE
(MTAG '80)

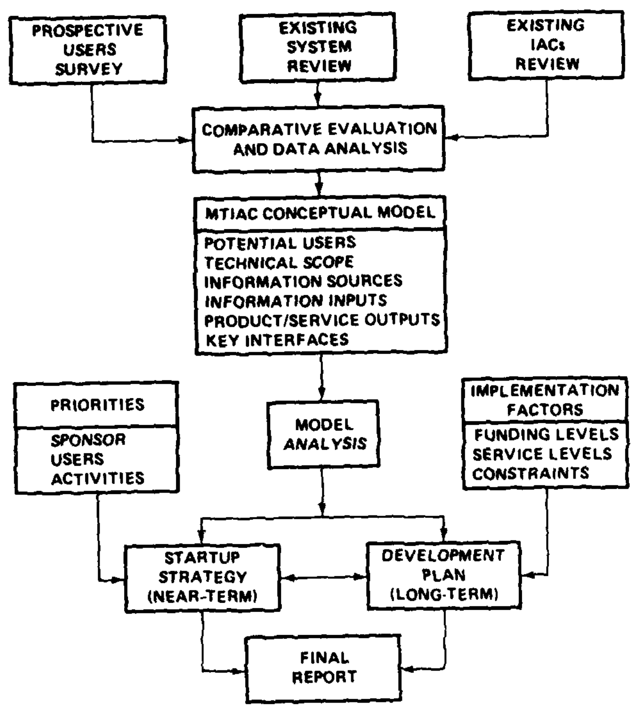
TEMPO

STUDY PURPOSE AND TASKS

- ASSESS MTIAC
  - –NEED AND DESIREABILITY
  - –SCOPE OF ACTIVITIES
- DETERMINE POTENTIAL
  - –USERS AND INFORMATION NEEDS
  - –SOURCES AND INPUTS
  - –OUTPUT PRODUCTS/SERVICES
- DEFINE
  - –EXISTING SYSTEM
  - –INTERFACES WITH OTHER IACs/DATA BASES
- IDENTIFY
  - –OPERATIONAL CONSIDERATIONS
  - –CONSTRAINTS
- DEVELOP
  - –START UP STRATEGY
  - –IMPLEMENTATION PLAN

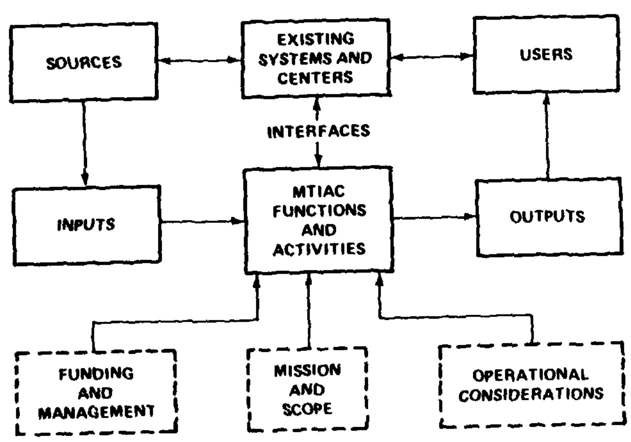
TEMPO

STUDY APPROACH



TEMPO

MTIAC MODEL FRAMEWORK



TEMPO

WHY IS AN MTIAC NEEDED?

90% POTENTIAL USERS CONTACTED SUPPORT MTIAC CONCEPT

BECAUSE IT COULD. . .

- IMPROVE DIFFUSION OF TECHNOLOGY RESULTING FROM DOD MT PROGRAM
  - WITHIN DEFENSE SECTOR
  - TO NON-DEFENSE MANUFACTURERS
- ADVOCATE, MONITOR AND COORDINATE R&D, APPLICATION AND DEMON STRATION EFFORTS FOR PROMISING MT DEVFLOPMENTS
- ALLEVIATE MT INFORMATION PROBLEMS ASSOCIATED WITH
  - QUANTITY/QUALITY OF MT LITERATURE
  - AVAILABILITY/TIMELINESS OF MT DATA
  - GAPS/DUPLICATION/LESSONS LEARNED IN MT EFFORTS
- ANALYZE AND PRODUCE INFORMATION RELEVANT TO MT NEEDS, CURRENT RESEARCH, ADVANCED DEVELOPMENT, AND TRENDS
- FURNISH TECHNICAL INFORMATION SUPPORT TO DOD MTAG COMMITTEES AND SUBCOMMITTEES

TEMPO

POTENTIAL USERS SURVEY RESPONSE

(700 Surveyed—370 Responses)

• MTAG AND MILITARY MT DEPARTMENTS	18%
• DOD CONTRACTORS	50%
• NON-DoD INDUSTRIES*	26%
• PROFESSIONAL/TRADE SOCIETIES*	3%
• UNIVERSITY/RESEARCH CENTERS*	3%

*RESPONSES AVERAGED TOGETHER UNDER "OTHER"

PRIORITY RANKING OF RESPONSES

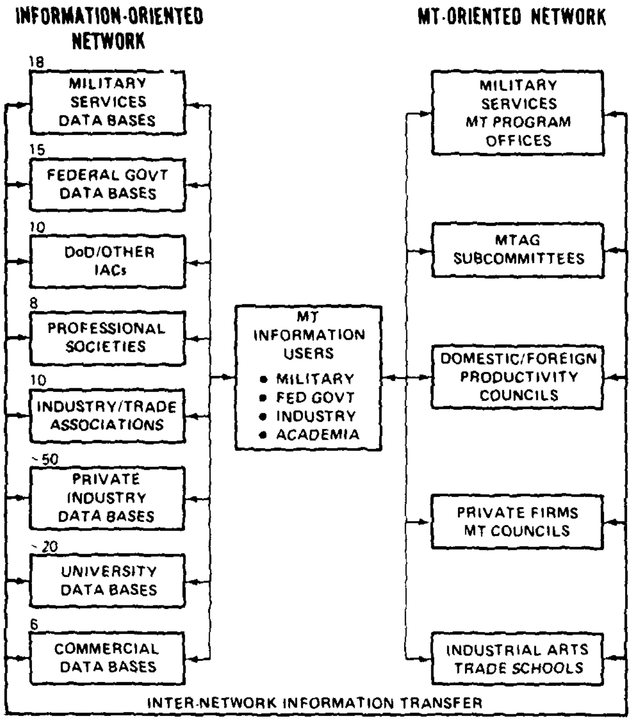
- **PREDOMINATE M.T. AREAS OF INTEREST**

	DoD CONTRACTORS	OTHERS
PROCESSES AND METHODS	1st	1st
AUTOMATED MANUFACTURE	2nd	2nd
CAM/CAD/CAT	3rd	3rd
MATERIALS	3rd	3rd

- **PRODUCTS/SERVICES REQUESTED**

	MTAG AND MILITARY	DoD CONTRACTORS	OTHER
DoD MT PROJECTS DATA BASE	1st	1st	–
QUICK RESPONSE TO INQUIRY	1st	2nd	2nd
STATE OF ART REVIEWS	2nd	1st	1st
CURRENT AWARENESS NEWSLETTER	3rd	3rd	3rd
INDEXED ABSTRACTS	2nd	3rd	4th
TECHNOLOGY NOTES	3rd	4th	3rd

EXISTING MT INFORMATION SYSTEM



INFORMATION SOURCES AND INPUTS

SOURCES	DISSEMINATION MEDIA
FEDERAL GOVERNMENT DATA BASES	DoD/GOVERNMENT REPORTS
MILITARY SERVICES DATA BASES	NON-GOVERNMENT REPORTS
DLA-FUNDED/OTHER IAC'S	TECHNICAL JOURNALS
PROFESSIONAL SOCIETIES	CONFERENCE PROCEEDINGS
INDUSTRY/TRADE ASSOCIATIONS	BOOKS, STANDARDS AND OTHER
PRIVATE-INDUSTRY DATA BASES	BIBLIOGRAPHIES AND NEWSLETTERS
UNIVERSITIES/TRADE SCHOOLS	MT PROJECT DATA
COMMERCIAL PUBLISHERS	TRAINING MATERIALS

TEMPO

MTIAC TECHNICAL SCOPE

NEAR-TERM EMPHASIS

CRITERIA

- DoD MT PROJECTS
  - –COMPLETED
- DUPLICATION AVOIDANCE
  - –OTHER DoD CENTERS
- *MT EMPHASIS*
  - –PERVASIVE MT AREAS
  - –FAST/HIGH PAYOFF

KEY MT AREAS

- CAD/CAM (ICAM)
- *ELECTRONICS FABRICATION*
- *COMPOSITES* FABRICATION
- *AUTOMATED* MANUFACTURE
- ADVANCED METALS PROCESSES

TEMPO

MTIAC TECHNICAL SCOPE

FUTURE DEVELOPMENT

CRITERIA

- MT PROJECTS
  - –ALL DoD
  - –NON-DoD DEVELOPMENTS
- ADDED MT EMPHASIS
  - –ENERGY EFFICIENCY
  - –MATERIALS *SUBSTITUTION*
  - –ENVIRONMENTAL CONCERNS

MT COVERAGE

- ALL MT AREAS
  - –NON DUPLICATED
  - –*RELATE TO DoD GOALS*
  - –SATISFY USERS NEEDS

EXPANDED SERVICE

- NON-DoD PRIVATE SECTOR
- ON-LINE DATA EXCHANGE

MTIAC FUNDING AND MANAGEMENT

FUNDS

OFFICE OF SECRETARY OF DEFENSE	10%
MILITARY SERVICES MT PROGRAMS	90%

MANAGEMENT AND OPERATIONS

- DATA BASE DEVELOPMENT/MAINTENANCE
  - –DoD MT PROJECTS (OSD)
  - –BIBLIOGRAPHIC FILE (DTIC)
- INQUIRY SERVICES (CONTRACTOR)
- CURRENT AWARENESS (CONTRACTOR)
- PUBLICATIONS (CONTRACTOR)
- CONFERENCE/SYMPOSIA
  - –SPONSORSHIP/MANAGEMENT (MILITARY SERVICES)
  - –PROCEEDINGS/SUPPORT (CONTRACTOR)
- MTAG SUPPORT (MILITARY SERVICES & CONTRACTOR)
- *TRAINING SUPPORT*
  - –EOP DEMONSTRATIONS (MILITARY SERVICES)
  - –MEDIA MATERIALS (CONTRACTOR)

ANNUAL FUNDING LEVELS AND ACTIVITIES

\$400-\$700K (BASELINE SERVICE LEVEL)	\$700K-\$1000K	\$1000K PLUS
• MTAG/SUPPORT		
• DATA BASE MAINTENANCE BIBLIOGRAPHIC FILE (DTIC SUPPORT) DOCUMENT COLLECTION	DoD MT PROJECTS (OSD SUPPORT)	MT RESOURCES FILE
• PUBLICATIONS STATE OF THE ART REPORTS CRITICAL REVIEWS	HANDBOOKS/DATABOOKS TECHNICAL JOURNAL MT RESOURCES GUIDE	TECHNOLOGY NOTES SPECIAL STUDIES
• CONFERENCES/SYMPOSIA PROCEEDINGS	SPONSOR/MANAGEMENT SUPPORT APPLICATION WORKSHOP	
• TRAINING SUPPORT EOP DEMOS, PROMOTION	FILM COLLECTION	MEDIA MATERIALS SHORT COURSES
• INQUIRY SERVICES TECHNICAL REFERRAL	DoD MT PROJECTS DATA	MT EXPERTISE/CAPABILITIES
• CURRENT AWARENESS NEWSLETTER BIBLIOGRAPHIES		SDI SERVICES

MTIAC IMPEMENTATION – STARTUP STRATEGY

PLANNING ELEMENT	NEAR-TERM EMPHASIS
• USAGE AND USERS	INITIAL LIMITED ACCESS – DOD MT PROGRAM PERSONNEL – DEFENSE CONTRACTORS – PROFESSIONAL SOCIETIES
• INFORMATION DISSEMINATION	COMPLETED DOD MT PROJECT RESULTS
• TECHNICAL SCOPE	KEY DOD MT AREAS
• DATA BASES TO SERVICE INQUIRIES	BIBLIOGRAPHIC (VIA DTIC) COMPLETED, ONGOING AND PLANNED MT PROJECTS (VIA DOD SYSTEM)
• LITERATURE COLLECTION	COMPLETED DOD MT PROJECT REPORTS JOURNALS/ABSTRACTS
• PUBLICATIONS	NEWSLETTER DOD MT JOURNAL 2-4 STATE-OF-ART REVIEWS CONFERENCE PROCEEDINGS SPECIAL BIBLIOGRAPHIES
• CONFERENCES/SYMPOSIA	2-4 KEY DOD MT AREAS
• DOD/MTAG SUPPORT	MT PROJECT RESULTS IMPLEMENTATION ANALYSIS
• FUNDING SOURCE	OSD – 10% SERVICES – 90%
• FUNDING LEVEL	$400K–$700K/YR

OTHER CONSIDERATIONS AND ISSUES

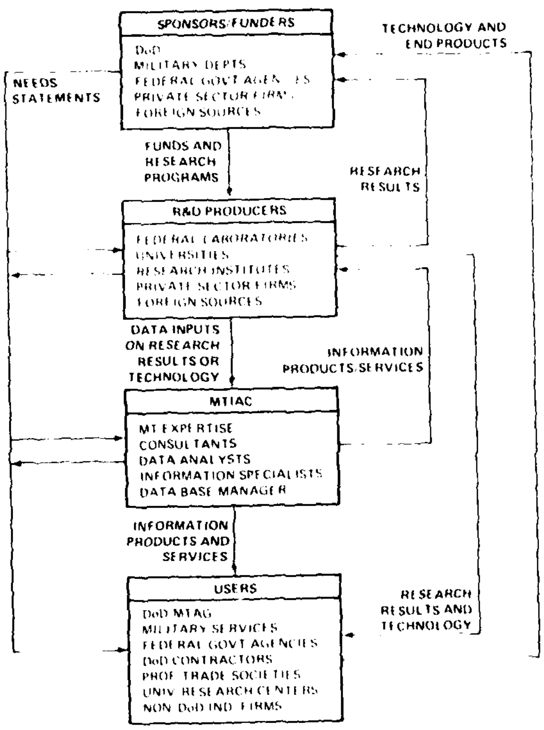
- RELATED PROGRAM INTERFACES
  –DOC-COOPERATIVE TECHNOLOGY PROGRAM
  –NTIS-CENTER FOR UTILIZATION OF FED. TECHNOLOGY
  –NASA-INDUSTRIAL/STATE TECHNOLOGY APPLICATION CENTERS

- BREADTH OF TECHNOLOGY COVERAGE
  –USERS/USAGE VS CONSTRAINED/UNCONSTRAINED
  –CLASSIFICATION SCHEME FOR STRUCTURING MT DATA BASE

- INFORMATION CONTROL/DISSEMINATION SAFEGUARDS
  –CLASSIFIED INFORMATION
  –PROPRIETARY INFORMATION
  –EXPORT-LIMITED CRITICAL TECHNOLOGY

- ASSOCIATED ISSUES COVERAGE
  –ENERGY CONSERVATION
  –CRITICAL MATERIAL SUBSTITUTES
  –OCCUPATIONAL SAFETY AND HEALTH
  –ENVIRONMENTAL CONCERNS

MTIAC TECHNOLOGY TRANSFER ROLE



NASA TECHNOLOGY TRANSFER

by

MR. FLOYD I. ROBERSON

Director, Technology Transfer Division
NASA Scientific and Technical Information Facility

In drafting the legislation that established NASA, the Congress recognized the byproduct potential for public benefit in aerospace-generated technology. Accordingly, the Congress dircted that NASA "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof," in order to maximmize the inherent benefit and thus realize an extra devidend on the aerospace investment.

NASA's means of discharging this responsibility if the Technology Transfer Program, a multifaceted effort designed to facilitate the use of aerospace technology in public and private sector applications; the program serves as a link between the developers of technology and those who might be able to employ it to the advantage of the nation's economy and productivity, and to improvement in the quality of life of its citizens. Since 1962, NASA has endeavored to stimulate innovation by encouraging the secondary application of technology originally developed for the agency's mainline programs. In recent years, the program has been expanded to include activities aimed at spurring awareness and interest in the relatively new and promising technology of satelite remote sensing.

The wealth of aerospace technology generated by NASA programs is an important resource, a foundation for development of new products and processes with resultant contribution to expanded national productivity. In a dormant state, however, the technology has only potential benefit. One of NASA'S jobs is to translate that potential into reality by putting the technology to work in new applications. The instrument of this objective is the Technology Transfer Program.

The program's aim is to increase the return on the national aerospace investment by identifying new ways to employ aerospace technology and by making the technology more readily available to prospective users. The effort embraces two major areas: (1) facilitating broader application of remote sensing technology and (2) fostering technology utilization, or encouraging re-use of technology emerging from NASA's mainline programs.

In the technology utilization element of the program, NASA promotes secondary application of aerospace technology by disseminating information on the technology available for transfer, by assisting industry in the transfer process, and by adapting existing aerospace technology to the solution of public sector problems.

Focal point of the program is the Technology Transfer Division, a component of NASA's Office of Space and Terrestrial Applications headquartered in Washington, D.C. The division coordinates the activities of a nationwide network of technologists who provide a link between the developers of aerospace technology and those who might effectively employ it. The mechanisms employed to meet program objectives include:

Applications engineering projects, wherein NASA, in cooperation with the private sector, undertakes adaptation of existing technology to specified needs of government agencies and public sector groups

Application teams, multidisciplinary groups of technologists who provide technology-matching and problem-solving assistance to public sector organizations.

A network of dissemination centers, channels through which industrial firms and other organizations interested in secondary utilization of technology may avail themselves of NASA scientific, technical and management expertise.

Publications and announcement media, designed to acquaint potential users with available technologies emanating from aerospace research and development.

A specialized center which provides aerospace-developed and other government-generated computer programs adaptable to the needs of industry and government agencies.

Technology Applications

One facet of NASA's Technology Transfer Program is its applications engineering effort, which involves the use of NASA expertise to redesign and reengineer existing aerospace technology for the solution of problems encountered by federal agencies or other public sector institutions.

Applications engineering projects originate in one of three ways. Some stem from requests for NASA assistance from other government agencies; others are generated by NASA technologists who perceive possible solutions to public sector problems by adapting NASA technology to the need. NASA also employs six application teams, each team composed of several scientists and engineers representing different areas of expertise. These teams contact public sector agencies, medical institutions, trade and professional organizations to uncover significant problems which might be susceptible to solution by application of NASA technology. Located at reasearch institutes and universities, the application teams concentrate their efforts in the fields of health care, public safety, transportation and industrial productivity.

An example of an application team effort is the technical assistance provided the Metropolitan Dade County (Florida) Office of Transportation Administration (OTA) in the design phase of the 21-mile

Greater Miami Metrorail rapid transit system, which is now under construction and scheduled for operational service in 1983. NASA participation stemmed from discussions between OTA and Kennedy Space Center regarding applicability of NASA technology to the Metrorail project. Subsequently, the Technology Applications Team at SRI International, Menlo Park, California initiated a program to apply NASA engineering and management technology to Metrorail problem areas. SRI assigned an experienced, NASA-trained engineer to serve as full-time representative to OTA. His job was to examine transit design problems; identify areas where NASA had already achieved applicable solutions or could bring its general expertise to bear; contact the appropriate NASA center; and relay the information acquired to OTA.

From 1977 until NASA participation was concluded in 1979, the representative investigated and forwarded to OTA information on such management methodologies as risk and configuration control, and such hardware technologies as anti-corrosion measures, fire and lightning protection, solar energy utilization and materials selection. when Dade Country approved recommended actions in these and other areas, they were implemented with further NASA assistance supplied by scientists, engineers and managers from NASA field centers. This technology approach was described by OTA's Director of Transit System Development as one that "appears to have both workability and merit."

Another example is an energy-saving device called the Power Factor Controller invented by a Marshall Space Flight Center engineer as a means of reducing power wastage in alternating current (AC) induction motors. In this type of motor, a substantial percentage of the power consumed is cast off in the form of heat, hence wasted. The wastage is caused by the current flowing through the motor, the amount of which is established by the fixed voltage--120 volts in most American homes--on which the motor operates. Power companies supply 120 volts because that is the voltage needed by common household motors to pull the heaviest loads they are designed to carry. A motor usually does not operate under full load conditions, but even when it is idling it is still getting 120 volts; this creates essentially the same current flow and resulting heat loss experienced when the motor is working hard. In short, the AC motor does not always need 120 volts since its actual voltage need varies with the amount of work it is doing. But with voltage being supplied at the fixed level to multimillions of motors in the United States, the cumulative power wastage is of enormous order.

The Power Factor Controller offers extraordinary energy conservation potential by virtue of its ability to match voltage and current flow with the motor's need. Plugged into a motor, the device can continuously determine load by sensing shifts in the relationship between voltage and current flow. When the controller senses a light load, it cuts the voltage level to the minimum needed, which in turn reduces current flow and heat loss. Laboratory tests howed the device capable of reducing the amount of power used by up to 6-8 percent under normal motor load and up to 65 percent when the motor was idling.

The Power Factor Controller concept originated in Marshall Space Flight Center's solar heating and cooling work for the Department of Energy (DoE). DoE plans extensive laboratory testing and a service-use test of the controller in a large textile manufacturing facility which has hundreds of electric motors. Under technology utilization funding, NASA is conducting further development to broaden the potential of the device by increasing its reliability, reducing its size and expanding the types of motors to which it can be applied. NASA has approved about 160 licensees for manufacture of the Power Factor Controller and additional applications for licenses are pending for both domestic and foreign markets.

Dissemination Centers

To promote technology transfer, NASA operates a network of dissemination centers whose job is to provide information retrieval services and technical assistance to industrial and government clients. The network consists of seven Indujstrial Applications Centers (IAC) and two State Technology Applications Centers (STAC) affiliated with universities across the country, each serving a geographical area. The centers are backed by off-site representatives in many major cities and by technology coordinators at NASA field centers; the latter seek to match NASA expertise and ongoing research and engineering with client problems and interests.

The network's princip' resource is a vast storehouse of accumulated technical knowledge, computerized for ready retrieval. Through the applications centers, clients have access to some 10 million documents, one of the world's largest repositories of technical data. Almost two million of these documents are contained in the NASA data bank, which includes reports covering every field of aerospace-related activity plus the continually updated contents of 15,000 scientific and technical journals.

Intended to prevent wasteful duplication of research already accomplished, the IACs endeavor to broaden and expedite technology transfer by helping industry to find and apply information pertinent to a company's projects or problems. By taking advantage of IAC services, businesses can save time and money and the nation benefits through increased industrial efficiency and productivity.

Staffed by scientists, engineers and computer retrieval specialists, the IACs provide three basic types of services. To an industrial firm contemplating a new research and development program or

seeking to solve a problem, they offer "retrospective searches"; they probe appropriate data banks for relevant literature and provide abstracts or full-text reports on subjects applicable to the company's needs. IACs also provide "current awareness" services, tailored periodic reports designed to keep a company's executives or engineers abreast of the latest developments in their fields with a minimal investment of time. Additionally, IAC applications engineers offer highly skilled assistance in applying the information retrieved to the company's best advantage. The IACs charge a nominal fee for their services.

The State Technology Applications Centers supplement the IAC system. They facilitate technology transfer to state and local governments, as well as to private industry, by working with existing state mechanisms for providing technical assistance. The STACs perform services similar to those of the IACs, but where the IAC operates on a regional basis, the STAC works within an individual state. In effect, the STAC program focuses on areas not normally served by the IACs, especially in the less industrialized states and among small businesses.

Publications

An essential step in promoting greater use of NASA technology is letting potential users know what NASA-developed information and technologies are available for transfer. This is accomplished by means of several types of publications.

The National Aeronautics and Space Act requires NASA contractors to furnish written reports containing technical information about inventions, improvements or innovations developed in the course of work for NASA. These reports provide input to NASA's principal technology utilization publication, Tech Briefs. Issued quarterly, Tech Briefs provides current awareness or problem-solving tools for its more than 60,000 industrial subscribers. Each issue contains information on approximately 150 newly-developed processes, advances in basic and applied research, improvements in shop and laboratory techniques, new sources of technical data and computer programs.

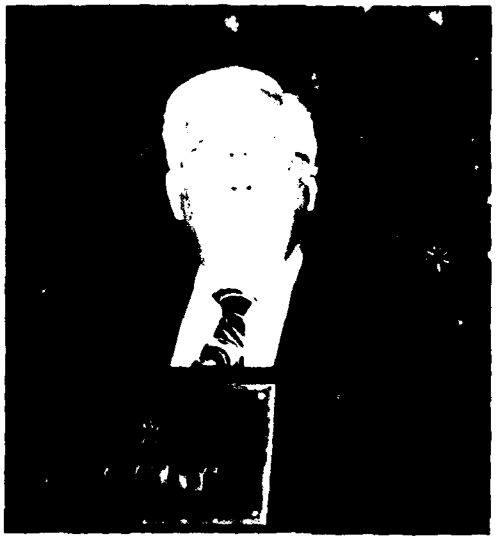
Interested firms can follow up by requesting a Technical Support Package, which provides more detailed information on a particular product or process described in the publication. Innovations reported in Tech Briefs last year generated almost 200,000 requests for additional information, concrete evidence that the publication is playing an important part in inspiring broader secondary use of NASA technology.

Subscription to Tech Briefs is free to engineers in U.S. industry, business executives, state and local government officials and other qualified technology transfer agents. The publication may be obtained by writing to the Director, Technology Transfer Division, NASA Scientific and Technical Information Facility, Post Office Box 8757, Baltimore/Washington International Airport, Maryland 21240.

NASA also publishes the announcement bulletin Computer Program Abstracts and a variety of special publications. The latter are reports, technical handbooks and data compilations designed to acquaint the non-aerospace user with NASA advances in various states of the art. Most of these publications are available through the National Technical Information Service, Springfield, Virginia 22161. A list of titles and prices is available from the Director, Technology Transfer Division, at the address listed earlier.

Software Center

Like hardware technology, computer programs have secondary applicability; programs developed for one purpose can often be adapted to another. To help industrial firms, government agencie and other organizations take advantage of this type of technology transfer, NASA operates the Computer Software Management and Information Center (COSMIC), located at the University of Georgis. COSMIC collects, screens and stores computer programs developed by NASA and other technology-generating agencies of the government. The center's library contains more than 1,500 programs, which perform such tasks as structural analysis, electronic circuit design, chemical analysis, design of fluid systems, determination of building energy requirements and a variety of toher functions. COSMIC offers these programs at a fraction of their original cost and the service has found wide acceptance. Availability of potentially adaptable programs is announced in the NASA publication Computer Program Abstracts, which may be obtained through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.



AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

by

MR. ROBERT E. HILCHEY

Chairman, Manufacturing Technology Division, ADPA
Vice President, Production Operations
Rockwell International

For more than a century and a half we have been living off the fruits ... the laurels ... the innovativeness ... the drive and momentum of our first productive rebellion ... The Industrial Revolution.

Today I want to advocate another insurrection. A new rebellion. A second industrial revolution, if you will.

It should be one marked by innovative thought and dramatic action. This revolution, or re-industrialization of america, must occur if we as a nation are to fluorish as the leading technological and productive society on the face of the globe.

To achieve this we must go back to the basics in diagnosing the ills of our productivity.

We must re-think. We must re-visit. We must re-analyze all of our productive processes -- even the most accepted and sacrosanct. We must challenge all that we are currently doing -- from ground zero -- in a spirit of discovery ... of creativity ... and of boldness in order to achieve progress.

For whether we like to admit it or not, we are in a state of economic warfare on an international scale ... (for the future of American business and industry lies not solely within its own borders ... but it must expand and compete in every area of the globe. And it must do this against an ever-increasing number of astute, sophisticated and aggressive marketing and producing nations.)

And if anyone thinks the term "Economic Warfare" is too strong an analogy, you only have to call to mind that while the Japanese and German auto industry is booming, we have 750,000 autoworkers on "Indefinite Leave" ... You only have to walk into a sound equipment store and try to find an American made stereo ... portable radio ... or tape recorder ... or step into a camera shop. Find a quality 35 millimeter American-made camera there ... and I'll buy it for you on your next birthday.

The international marketplace can no longer be treated as a mere appendage to domestic markets. And productivity is the pivotal operation in industry that will determine just what share of the world market we will capture -- or in negative terms -- may fail to capture.

In brief, to be competitive we must improve our productivity -- and improve it exponentially and swiftly ... Then we can walk tall ... Fail in that effort -- and we fall. It is as simple as that ... and as critical as that.

We all recall from our history books the image of those nineteenth century tall ships -- The Yankee Clippers commanded by bold skippers -- as they blazed world markets. They carried a wealth of products from the factories of that emerging North American industrial giant -- the United States. This successful worldwide marketing venture -- reflecting American productive vitality -- continued well into the twentieth century beyond World War Two.

But the nineteen sixties, foul weather warning flags were flying for American business venture. By then other industrial nations were flexing their muscles. They were beginning to beat us at our own game ... cost-effective industrial production.

With their creative use of capital ... with new production technques ... with modernized facilities ... and with their governments giving them one hundred percent backing .. almost overnight they leapfrogged our own technology ... and we helped them do it. I'm not, at this point, referring to any deliberate and direct post World War Two aid -- but to an inadvertent assist. It occurred through a very human phenomenon -- known as "Default."

For in the production area we not only lost sight of the ball -- we even lost sight of the goal during our preoccupation with other matters in the sixties and the seventies.

We are where we are today -- I contend -- because of an extreme case of "Benign Neglect." We were preoccupied with periods of heavy government regulation ... cleaning up our smoke stack emissions ... our toilets ... and putting fire extinguishers precisely three point eight feet above the floor line.

We've coped with that now ... along with social and other environmental issues. We've learned to live with them. An while we were doing all of that fiddling -- American productivity burned. We let things slide.

We paid mere tokenism to capital investment in terms of its innova[illegible] use to develop new production processes.

We've abdicated to foreign nations some of those areas of technology that we used to be leaders in: knitting mills ... exotic machining tool devices ... and equipment. Advances in the world of metal technology ... and dozens of other areas.

With all of the preoccupation of the sixties and the seventies we let our productivity slip to dangerously low levels.

Look at our factories. Too many are old -- antiquated and should be plowed under. And even those brand new factories frequently reflect antiquated production thinking -- cloaked, of course, in modern brick, chrome, and glass.

According to a recent government report (Note: This refers to article in September 1980 Atlantic Monthly referring to a General Accounting Office report) the average piece of equipment in the machine tool industry is twenty years old. The average open hearth furnace in the steel industry is thirty-three years old -- and the average equipment age for the whole industry is seventeen years.

Foreign operators have been much more astute in keeping their factories modernized. It's true -- they had the advantage after World Ware Two of starting from scratch with modernized buildings and equipment. But that's just a handy excuse for us to use. A crutch ... and a rubber crutch at that. Because they have continually updated their facilities ever since World War Two. They've kept ahead of us. We have not re-done our base of manufacturing. And they have -- every ten or fifteen years.

When we design our manufacturing complexes, why do we insist on spreading the buildings all over God's creation? Why don't we insist on butting them next to each other? Thereby reducing the need for massive internal trucking fleets and a driver force to man them. Are our factory designers and industrial engineers merely repeating the concepts and layouts they found in their classroom textbooks? ... Thus perpetuating basic flaws that we should really be challenging?

If we compare the average size of the American factory to that of some of our foreign competitors we can see that ours may be as much as three times as large -- yet both are designed for the same output ... Now I realize that on the average the Japanese worker is a bit smaller that his American counterpart -- <u>But Three Times As Small</u>?

Let's design profit into our factories. And it isn't designing profit into them when we have situations where it takes two to three people to transport materials so that one person can work on them.

We must challenge the very basics of factory design. Let's take a hard look at hold areas ... Our theories and practices of queing. We have to reconsider everything, every stage, every facet of our total production force -- and resist succumbing to habit -- that routine acceptance of what went on yesterday will be just great for today and for tomorrow. Habit is the opium of those of us responsible for productivity. We have to look afresh at everything.

For example, every day I look out of my office window at our own loading docks ... I think half of the trucks in America are at loading docks -- and the other half are waiting in line ... Have we ever thought how much time and money is wasted in laoding and unloading trucks? Have we ever seriously thought that there just might be a better way? Why not load and unload tucks from the side? Of course, we can't now -- They don't have hinged sides. They aren't designed that way. But because we had trucks with back door design in 1980 -- does that mean that they should still have the same design in 1980 ... or 90 ... or the year two thousand and eight?

We simply have to get back to the basics -- and face reality. Let's all stop looking at the emperor and agreeing about the wonderful clothes he has on. All of us have to have a bit of that little boy in us who saw the emperor in his reality -- stark naked -- with his warts, blemishes and defects showing -- and start from there.

Every time we think of the word productivity we must be aware that subsumed in that word is the concept of "Profit." For nothing determines the profit -- or lack of it -- for a company more than its productivity.

A mere increase in the number of widgets means nothing -- unless they are produced cost effectively ... profitably ... competitively within the world market ... I'm afraid many of us who hold responsible productivity offices fail to appreciate this legitimate profit motive -- for productivity without profit is industrial suicide -- which in our free enterprise system means the suicide of our entire society ... workers, management, stockholders, government ... We'll all go down the tubes together.

When we speak of productivity without profit it reminds me of an incident that occurred in a little tourist town in the Tennessee Hills ....

This town attracted a great number of tourists .... It was a quaint town .... with a very pleasant nineteenth century atmosphere about it. In the town square there was a big old civil war cannon -- a favorite place for the tourists to lounge and to take pictures of each other around the cannon. The city fathers were happy with the way things were going for their tourist business -- except one thing troubled them .... the village reprobate .... "Old Harry" .... Harry, it seems, would sit there in the village square dressed in smelly, tattered clothes .... ever so often take a swig of good old mountain kool aid .... and openly ogle the more attractive lady tourists.

To the city council he was about as welcome as King Kong in a fruit stand. So they came up with an

idea. "Let's give him a job," they said. "We'll pay him at least a nominal amount to get that cannon in good shape and keep it that way." Harry accepted the offer. It was the first time anyone had really gone out and offered him something constructive to do.

And he performed beautifully. In time he became the best cannon polisher south of the Mason Dixon Line. He was proud of his job. He dressed neatly and if he still sipped that kool aid he did it discreetly. The cannon was so shiny it would hurt your eyes to look at it on a sunny day .... There wasn't a speck of rust on the iron work .... The wood was well oiled -- It really was the best looking cannon in captivity.

For fifteen years things went great. Then one night he came to the city council meeting and shocked them. He told them he was quitting.

The mayor was startled. He told Harry that the city council was more than happy with his work as a cannon polisher. They thought he was tops and that the cannon without a doubt was the best looking one in any square in the United States -- and probably Mexico, Nicaragua and Canada, too.

"Why, that's just it," Harry answered. "I've saved up my money .... I bought my own cannon .... and now I'm going into business for myself."

I'm afraid if we're not careful with our productive efficiency too many of our companies may wind up as being in the cannon polishing business .... which brings me to the topic of "Jobs I would like to see re-evaluated."

Now when I go down this list, please bear in mind that I'm not advocating the intensification of the unemployment problem. On the contrary, I want to do away with non-proft making jobs so that we can create more real productive jobs.

What jobs would I like to see re-evaluated?

Expeditors ... Time Keepers ... Follow-Up Clerks ... Receiving Inspectors ... certain Program Managers ... many of the Quality Control and Middle Management people ... and a large percentage of staff.

If you want to consider a startling figure, then think about this: A recent issue of Atlantic Monthly pointed out that of all the industrialized nations, the United States is the only one who increased the number of employees in the manufacturing industries since the Arab Oil Boycott in 1973.

In other words -- our overseas friends have been busy multiplying -- and so have we. The only difference is that they've multiplied their productivity level -- and we've multiplied our labor force.

Beyond taking a critical and candid look at those non-productive jobs involved in the manufacturing area -- we have to take a look at the whole "Business Gestalt." For example, do we need libraries that to a large part duplicate those of nearby universities and metropolitan libraries. Do we need all of those librarians and librarians' assistants?

Do we need those acres and acres of lawns and greenhouse-type foliage that rival The Hanging Gardens of Babylon or The Tivoli Gardens in Copenhagen? How much money are we spending on cutting grass and other topiary arts. And how much does that add to the cost of the product? And how competitive does it make the product when it must compete against a similar German or Dutch or Japanese product in the foreign -- or domestic -- marketplace?

Not too long ago a Japanes delegation was touring an American plant in the Southwest. They stopped to look out of the plant's fourth floor window and peered across acres and acres of well manicured lawns. "What kind of crop are you raising," the Japanese visitor asked his guide. The guide looked puzzled and replied, "That's no crop. It's just grass."

"You mean all of that isn't something you're going to sell? It's not food? Not fodder?" the Japanese visitor asked. Puzzled no doubt -- and probably very pleased -- at out strange Yankee ways of doing business.

How many internal trucks do we have -- to move material 15 or 20 feet between buildings that should have been built closer together? How many company firemen? How many entries do we keep open that demand extra guards and receptionists.

So the bottom line question is: How many people do we have on the payroll that we really don't need in non-productive jobs -- who aren't gainfully employed in making the product?

Think about inventory for a moment. About the devastating effect inventory stock piling has on us today. If you took the Fortune Five Hundred list of corporations and totaled up their investment in inventory the amount would be staggering. The point is that if you reduced it by just ten percent and used that money for capital investment your problems of research and development funding, and investments for the future would disappear.

Just think about our labor classifications. And about our incentive practices. Do we really pay for performance and quality today? You know - and I know that we don't. But whatever happened to that principle? Did we abdicate something again? Something that is the rightful prerogative of ourselves, of our customers, and of our stockholders?

In the field of quality I feel as though we're in an Alice in Wonderland situation. Just think about it. We invented quality circles. An yet, what is happening today? The Japanese -- for one -- are practicing it to an art.

A recent magazine article referred to a general accounting office report which revealed that after a Japanese firm had taken over an American TV plant the rate of defects dropped from some 150 to 100 sets to an almost unbelievable rate of 3 or 4 defects per 100.

There's something wrong -- drastically wrong -- and not in Denmark my friends -- but right here in the U.S.A when we have problems like that. And the answer is <u>not</u> to add more quality control inspection stations.

With some surveys indicating that inspection stations may run as high as one out of every five places in an assembly line, we don't have much furtheer to go before we'll be on a one-on-one basis: One worker and an inspector standing at his elbow. We're just one step from the theatre of the absurd -- having more inspectors than we have workers.

So while the Japanese are busy practicing quality -- we in turn seem to neglect it -- or have attacked it from the wrong direction -- by adding personnel and therefore, cost upon cost to production.

Have we forgotten -- or are we terrified -- of worker involvement regarding quality? We've institutionalized quality without involving people. We've imposed layers of inspectors upon inspectors on top of the working system.

And now for the supreme irony -- we still have quality that is far from acceptable -- far too low -- and paradoxically at an extra high price.

If 80 percent of those in quality control went back to being a basic producer just think of the dramatic increase in productivity that would result. No longer would America be vying with our British cousins across the seas to see who will win out in holding the international anchor position for lowest productivity rates.

Look at the number of people doing receiving inspection -- a monument to our inability to do something right the first time.

You're no doubt familiar with a recent report in electronics magazine referring to a recent Hewlett-Packard study. Their survey indicates that Japanese chips have one tenth the defect rate of American-made chips.

Part of our problem in quality may well be the loss of the American work ethos. The sense of pride the American worker once had in his product is gone. But, of course, it is too simplistic to place the blame on the American worker -- and his sense of pride or lack thereof.

As John Kennedy said immmediately after the Bay of Pigs fiasco when everyone was pointing a finger at someone else -- "Don't worry -- There's enough blame to go around for everyone."

We in management must face the fact that the American corporation today has become much to impersonal. The sense of individual identification with a corporation is missing. We have not included the personal touch and concern in our corporations. But that doesn't mean we can't -- just that we haven't done it yet.

There aren't any rules that say we can't talk with our workers. And, if we are going to achieve that identity role of communication between manager and the workers -- that is, those people who really count, who make the widgets right the first time -- that we're going to have to accomplish a 180 degree reversal.

We've got to make certain to convey what our goals are. We've got to explain how everyone's fate hangs upon how successful we are in competing against foreign nations. If we don't get back to those basics -- the basics of people -- then all of the other peripheral things we do will have been done in vain.

Remember, the entire environment of American industry has changed from what it was in the past. What does this mean? For example, the work force is drastically different than it was forty years ago ... or thirty years ago ... or even ten years ago. It is a highly educated work force -- with people demanding different forms of satisfaction beyond mere wages and salaries.

Training and orientation are two areas in which we must do some soul searching. Wages will certainly

continue to escalate. But we still can do something to keep competitive and that is to increase efficiency -- both through motivational orientation and technical training.

Now I don't think we'll ever reach the stage that workers will start off the day by doing group calisthenics and singing the company song as happens in more than a few Japanese plants. But, leaving out such obvious emotional displays, let us look at some other things that our foreign competitors do -- that we have again benignly neglected.

The average Japanese employee experiences some 30 hours of annual training on the entry level. In the United States, we generally offer some brief on the job training and then turn the worker loose. Again, there are no rules against our revitalizing our employees training ... reorienting them to the big picture of where they fit in, how crucial they are to the success of the overall enterprise.

Beyond such motivational programs, industry bears a crucial and basic responsibility of recapitalization -- investing in the future. American firms on their own -- and with increased support from the government -- must invest in long term manufacturing capabilities. It is an unfortuntate fact of life that 90 percent of the robots being installed today are going into manufacturing facilities outside of the United States.

And motivation can't substitute for the right tools. As Senator Bentson of Texas said recently in criticizing American industry's lack of plant modernization, "Blaming lack of production on poor worker motivation is not addressing the full issue. For, if you take two able and willing workers, one with a power saw and one with a hand saw -- guess which one will cut the most Wood?"

It's just that simple. Motivation alone won't do it. Machinery alone won't either. But the combination of motivation and proper working tools and environment will take us a long way in getting back that productive lead we once held.

In management, we have fallen in love with the substance of structure without understanding what it is doing to us by additional layering of echelon upon echelon of management. One observer remarked that in U.S. corporations we have board chairmen, chief executive officers, presidents, vice presidents, assistant vice presidents, directors, managers, group heads, supervisors, leading foreman, just plain foremen -- and then if anyone is left over we may just have a few people left to do the work. In Japan they have far fewer layers of management.

However, all is not negative. For more and more people . . . laymen . . . those in government positions . . . as well as those in commerce and industry have become sensitive to out deteriorating competitive position in the world marketplace. For even in such vital areas as our defense production we are heavily dependent upon foreign purchases - - not for just raw materials but for manufactured parts and components.

I believe as a result we have a genuine national ground swell - - from the every day citizen, from workers, through management -- to take drastic action. A constructive, cooperative action to improve our world marketing/production position ... which, of course, will have a direct bearing, in time, upon inflation and employment.

What can we do?

No single group in the United States has more potential to remedy the situation than those of us here in this room this morning. We represent all of the armed forces and various other government agencies. We come from the major manufacturing enterprises of America. And we are members of key industrial associations.

We can return to our home bases with two choices. We can continue our "Benign Neglect." Or we can start that second industrial revolution. A positive, industrial revolution of the late twentieth century. By rattling cages. By making waves. By challenging. By questioning productive processes. By selling our own management, labor and individuals on the critical need to do something. And to do it now in righting productive wrongs.

As I'm sure you are aware, all of us like to take part in America's favorite pasttime of blaming our government for whatever we think is wrong in our society.

Certainly in our field, some government regulations have proved to be annoying at best - - and counterproductive at worst. But I'm here today to think in an upbeat manner. And to challenge you to do the same. Let's take a positive approach. Let's look at what we can do together. Industry - - and government - - working in concert to whip this productivity problem.

One of the most exciting programs in existence, I think, is the Department of Defense Manufacturing Technology Program - - offering an excellent opportunity for government and industry to further the cause of increased productivity by helping us to break loose from outmoded methods of manufacturing. Some two hundred million dollars is available for research into modernizing our productivity. Let us not fail to take advantage of this "Golden Opportunity" to help ourselves and our entire nation.

I would hope that other government incentives to increase venture capital and production would be forthcoming -- such as Bill 10-5-3, Capital Cost Recovery Act. (Senate Version 1435 and House 4646) Unfortunately, this bill has been on the back burner of Congress for more than a year now. If it would come to fruition - - And why shouldn't it - - we would see added incentives for business through more realistic depreciation policies.

I would hope, too, that there would be a reduction in unnecessary regulations and formal structuring of relationships that prevent suppliers of lower echelons from working in closer harmony and partnership arrangements with prime contractors.

This time is long past due for labor, business and government to begin to cooperate in the fullest meaning of that word.

Rather than bearing our fangs at each other - - let us form a partnership . . . a partnership dedicated toward building a common cause rather than tearing apart in an adversary relationship.

We all know the problem - - which is fifty percent of the battle. We know our real adversaries. We know where we have gone wrong - - and where we can go right.

We know what to do. And we know how to do it right.

We're all in this together. For we are all builders. Design Engineers . . . Marketers . . . Production Experts . . . and those men and women who are the grass roots, the backbone and heart of our production system - - The Workers. Yes, we're all builders in our own way . . . . .

I would like to close with a brief poem that so aptly expresses that thought of "Each of Us as a Builder." It was written by Edwin Markham some 80 years ago at the turn of the century:

"We are blind until we see
That in the human plan,
Nothing is worth the making if
It does not make the man.

"Why build these cities glorious
If Man unbuilded goes?
In vain we build the world unless
The builder also grows."

A D P A — "WHAT IT IS"

- NON-PROFIT - NON-POLITICAL
- GOVERNMENT - SCIENCE - INDUSTRY

"IMPROVE THE EFFECTIVENESS AND EFFICIENCY OF THE GOVERNMENT - SCIENCE - INDUSTRY RELATIONSHIP IN THE DEVELOPMENT AND PRODUCTION OF WEAPONS AND WEAPON SYSTEMS."

- TECHNIQUES - PROCESSES - MATERIALS
- KEEP MEMBERS AND PUBLIC INFORMED
- COOPERATE WITH TECHNICAL AND INDUSTRIAL ASSOCIATIONS
- NATIONAL DEFENSE STRONG - WAR AND PEACE

A D P A *MANUFACTURING* DIVISION SECTIONS	*DoD* M T A G SUBCOMMITTEE
CAD/CAM	CAD/CAM
ELECTRONICS	ELECTRONICS
INSPECTION AND TEST	INSPECTION AND TEST
NON-METALS	NON-METALS
METALS	METALS
MUNITIONS	MUNITIONS

PRODUCTIVITY GROWTH IN THE 80'S BY A SECOND INDUSTRIAL REVOLUTION

PRODUCTIVE IMPROVEMENT

- COMPETE

  OR

- FAIL

BACK TO BASICS

- RE-THINK
- RE-VISIT
- RE-ANALYZE
- CHALLENGE

PRODUCTIVITY SLOW DOWN

- GOVERNMENT REGULATIONS
- ENVIRONMENTAL
- SOCIAL
- CAPITAL INVESTMENT
- TECHNOLOGY

U.S. FACTORIES

- FACILITIES - OLD
- MACHINE TOOLS - OLD
- DESIGN
- SIZE
- PLANT LAYOUT

REDUCE OR ELIMINATE

- EXPEDITORS
- TIME KEEPERS
- FOLLOW-UP CLERKS
- RECEIVING INSPECTORS
- PROGRAM MANAGERS
- QUALITY CONTROL
- MIDDLE MANAGEMENT
- STAFF
- LIBRARIES
- LAWNS AND GREENHOUSES
- MATERIAL HANDLING
- GUARDS
- RECEPTIONISTS

MANAGEMENT ACTIONS

- REDUCE INVENTORIES
- BUILD IN QUALITY
- REDUCE INSPECTION

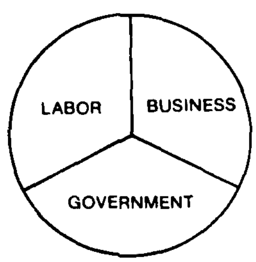
AMERICAN MANAGEMENT

- IMPERSONAL
- COMMUNICATIONS
- WORK FORCE
- TRAINING
- RIGHT TOOLS
- LAYERING

SECOND INDUSTRIAL REVOLUTION

- PUBLIC AWARENESS
- GOVERNMENT REGULATIONS
- DEPRECIATION
- DOD MTAG

COOPERATE FOR SURVIVAL



AEROSPACE INDUSTRIES ASSOCIATION

by

MR. RALPH PATSFALL

Manufacturing Committee, AIA
Managers Manufacturing Technology Operations
General Electric Corporation

PRECEDING PAGE BLANK-NOT FILMED

Good Morning, I am Ralph Patsfall and it is my pleasure to represent the Manufacturing Committee of the Aerospace Industries Association at this Twelth Annual Tri-Service Manufacturing Technology Conference. The theme of this meeting "Productivity Growth in The '80's," has highlighted the most significant challenge that Government, Industry and Academia will face in the next decade. As manager of the Manufacturing Technology Operation of General Electric's Aircraft Engine Group, I am more than aware of the significance of the role that manufacturing technology will play in providing the wherewithal to turn the tide from a productivity decrease our nation has encountered to a prosperous productivity growth increase.

For a few minutes this morning, I would like to share with you some of the activities and results achieved within the Manufacturing Committee of the AIA during the past year and provide you with several recommendations which we feel will increase the effectiveness of your manufacturing technology program in increasing productivity. I have chosen to direct these recommendations toward the recently formalized USAF program entitled "Technical Modernization or Tech-Mod." In a broader sense, manufacturing technology, either industry and/or government supported, is expected to provide the technology base for upgrading and modernizing our factories to meet and surpass our competition whether nationally or internationally, - provide a significant increase in productivity. This increase in productivity is necessary to provide not only for the defense of our country but also to solve many of our economic problems.

The Keys to productivity growth in the '80's are:

1. Technology
2. Capital Investment
3. Quality of the Labor Force
4. Management Effectiveness

These Keys are not new. Several studies have disclosed these same four major ingredients. This conference has as its goal, a review of the present and planned manufacturing technology programs as selected by our three services. Secondly, it will determine how effectively the dollars, which have been allocated, have been managed. The USAF Tech Mod program, I have mentioned, is converned with providing the contractual means for industry to provide the capital investment dollars necessary to increase productivity and lower the cost of weapon systems. It appears that this conference is addressing three of the Keys to productivity. I am sure that before the day is over you will hear the fourth Key, Quality of Labor, addressed.

The AIA is presently made up of 46 member companies with significant portions of their business in the aerospace sector. When productivity growth rate of the aerospace industry of 4.5% was compared to the growth rate of the national average of 2.7%, the industry was clearly ahead. When we consider that the Japanese are entering the aerospace market with a productivity growth rate of over 7%, we cannot rest on our laurel's. All of the member companies have productivity programs to increase their growth rate and remain competitive.

The executive committee of the Manufacturing Committee is made up of the manufacturing management of eight of the member companies. Extensive discussions have been held on the subject of Productivity. In fact, our Spring Committee meeting had a theme similar to this meeting, "Productivity, Challenge Of The '80's."

The executive committee has established three Manufacturing Technology Advisory Groups, MTAG's to assist them in their activities. They are:

1. Manufacturing Management Systems
2. Methods, Processes & Equipment
3. Computer Aided Manufacture

All of these MTAG's have recently been requested to review their activities with respect to productivity.

Several studies have recently been completed which have applicability to the productivity issue. A study was conducted of the member companies to ascertain what types of productivity programs were being conducted and how the effectiveness of these programs are being measured. The study revealed that all forms of productivity programs were being conducted, i.e., from Quality Circles to improved Value Engineering, and that agreement on how to measure productivity was impossible but that simple input over output was not a very satisfactory measurement.

Another study reviewed what skills training was occurring within AIA member companies and to highlight which skills were not adequately being developed. The major shortages were in formally trained manufacturing engineers and an inadequate supply of computer software engineers.

The transfer of technology within the industry was reviewed and was found to be difficult and occurring on a piecemeal basis. This issue is to be studied in more depth in the next year with the goal of establishing a better means of increasing the effectiveness and timeliness of technology transfer.

The introduction of the USAF Tech-Mod program has triggered considerable discussion and the positive and measured results achieved with the F-16 program at General Dynamics has become a model for these discussions. These discussions have led to the formalization of several recommendations as to how the interaction between Manufacturing Technology and Technical Modernization can be strengthened and become effective during the '80's, -- "Bridging the Gap."

To assure that you understand what is meant by "Gap," the four phases of manufacturing technology must be defined.

1. Feasibility establishment - IR&D
2. Scale-up of the technology
3. Pilot production using the technology
4. Production implementation of the technology

Manufacturing Technology encompasses phases 2 & 3, the technology must be developed to the point where specifications, process parameters and production yield and rate are developed before capital investments can be made to fully implement (Tech-Mod) the technology. In the past, few of the manufacturing technology programs as sponsored by DoD have progressed to the level where these investments could be made. The successful programs have been driven through the gap, primarily by demand for a new weapon system. The final two phases of the technology were supported by the acquisition contract for the weapon system. Since the number of new weapon systems planned is low, the number of technologies progressing over the gap will become even lower unless new methods for implementing manufacturing technology are developed.

In identifying an alternate method, some of the Gap drivers were identified and listed. I am sure, althrough not proposed as complete, that these drivers are recognized by this audience as significant and for the most part desired. Since our theme is productivity and I represent the Aerospace Industries Manufacturing Community, let us concentrate on how the manufacturing technology associates with manufacturing productivity. The Tri-Services in their program summaries have indicated interest in many of these areas and are in some cases indicated to be major thrusts. The importance of these drivers in increasing productivity in the aerospace industry is also recognized. It is now required that we manage the introduction of them in a timely and effective manner.

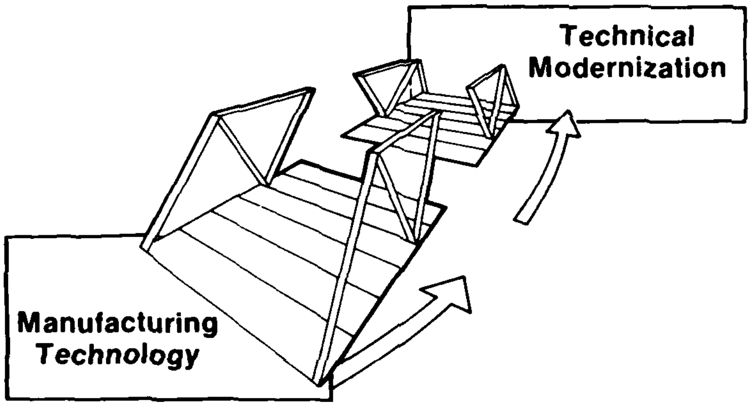
First, let us review how we managed the technology in the past. As previously mentioned product driven technology has generally been implemented. Technology which improves productivity and lowers cost has not had clear sailing unless it is generally applicable to the industry. Some have been specifically attached to a component of a weapons system which either did not go into production, such as the B-1 Bomber, or the number of systems to be purchased could not provide sufficient ROI to be implemented.

The proposed method is constructed to avoid some of the past pitfalls. In essence, it involves selecting large programs involving the integration of manufacturing technology into systems which will require the contractor(s) to tie together the smaller pieces of technology required to develop an operating system or center to establish a new technology frontier of the state-of-the-art. The automation of the milling of aircraft structural components by MBB in West Germany, is the magnitude type of programs the AIA would like to see the Tri-Services support. Machining cost is a significant portion of present and future aircraft and such a development would provide the technology to significantly impact the cost of airframes. The sheet metal and electronics wedge of the ICAM program are steps in the right direction but, we must assure that the demonstrations are complete, and are, with only minor modifications, adaptable by industry in a timely fashion.

I have recently visited both Japan and Europe, examining their state of manufacturing technology. I was more than impressed by the projects they have in operation or under development but most of the fundamental technology they use as an application base came from this country. I am convinced that this country has the technology to leap frog them in the near future if government, industry, and academia are joined together in a productivity thrust. The DoD Manufacturing Technology Program is the vehicle we must use to provide the desired Productivity Growth in the '80's.

Productivity Growth in the 80's

Aerospace Industry Association
Manufacturing Committee



Bridging the Gap

Keys to Productivity Growth in the 80's

- Technology
- Capital Investment
- Quality of Labor Force
- Management Effectiveness

Productivity Growth in the 80's

AIA Role

- **46 Member Companies**
  - Productivity Growth Rate 4.5% vs. National 2.7%
  - All Have Productivity Programs
- **Executive Committee**
  - 8 Major Aerospace Companies
  - Manufacturing Management
  - Extensive Discussions
- **MTAG's**
  - Manufacturing Management Systems (MMS)
  - Methods, Processes and Equipment (MPE)
  - Computer Aided Manufacture (CAM)

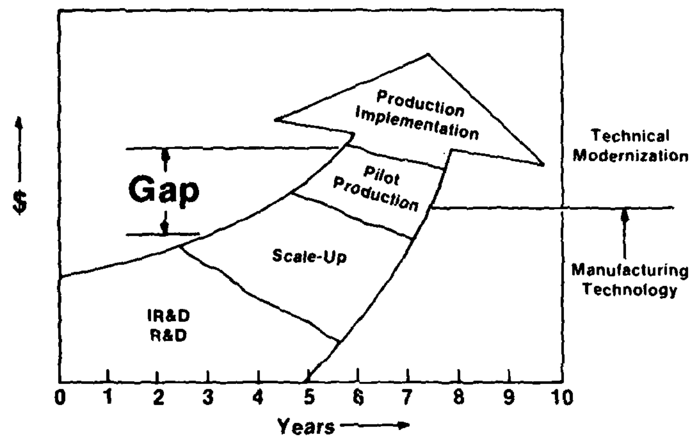
Productivity Growth in the 80's

AIA Role (Cont.)

- **Recent Studies**
  - Productivity
    - Difficult to Measure
    - All AIA Companies Emphasizing
  - Skills Training
    - Shortage Highlighted
      - *Computer Software Engineers*
      - Formal Manufacturing Engineer Education
  - Introduction/Transfer New Technology
    - Difficult
    - Piecemeal?
  - *Manufacturing Technology* → Technical Modernization

Manufacturing Technology—Technical Modernization

Manufacturing Technology Phases

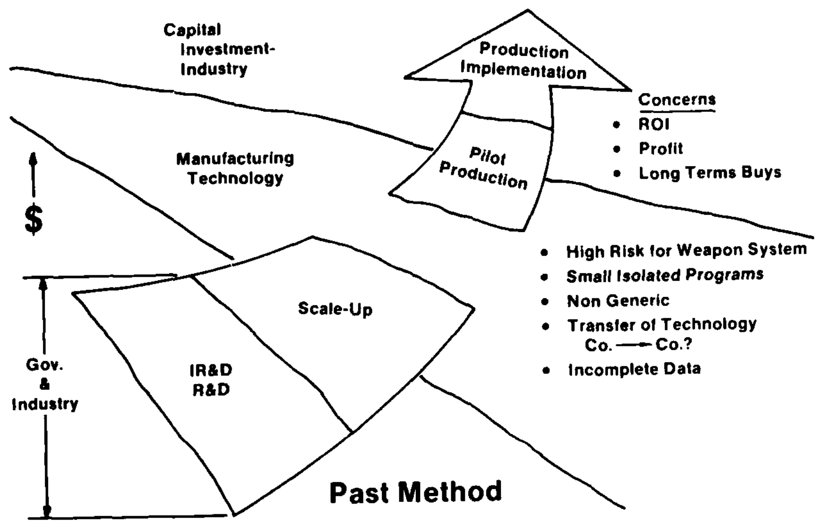


Manufacturing Technology—Technical Modernization

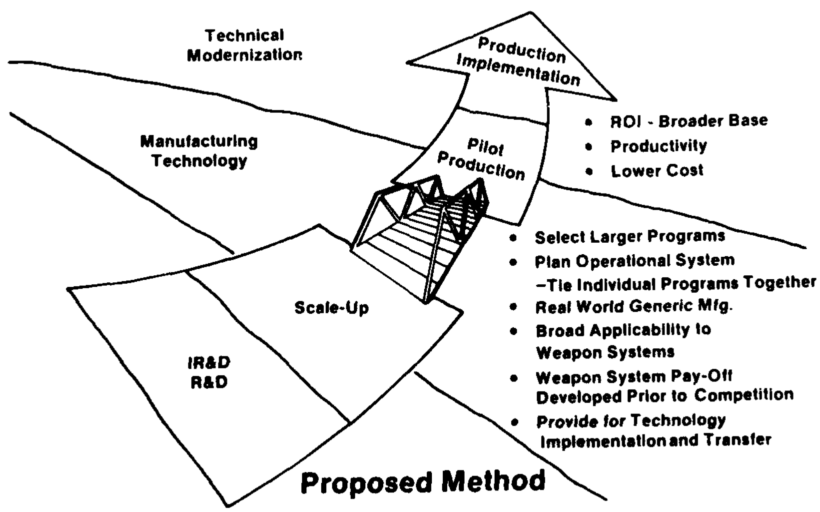
Gap Drivers

"Better Mousetrap" Product Design	"Cheaper Mousetrap" *Manufacturing Productivity*
• Hypersonic Flight	• CAM
• Stealth	• Automation
• Improved Aerodynamics	• Robotics
• New Materials	• High Speed Machining
• Increased Payload	• Near Net Shape
• Longer Life Cycle	• Composites Mechanization
• Mission	• Laser Processing
• Range	• Group Technology
	• Improved Cutting Tools

Manufacturing Technology—Technical Modernization



Manufacturing Technology—Technical Modernization



AMERICAN WELDING SOCIETY

by

MR. ROBERT C. HOLLAND

Vice President, Marketing
Control Laser Corporation

After an incubation period of some ten years, the laser is finally becoming accepted by industry as an important industrial tool. Ultimately, manufacturers have realized that the risk of replacing well-established approaches with a non-traditional, somewhat mysterious, high-technology technique is far outweighed by the benefits accrued namely:

- Fast cutting speeds with small kerf losses;
- Exceptionally long "tool" life -- a laser never dulls or breaks;
- Low heat input coupled with self-quenching;
- Minimal thermal distortion;
- Operates in a normal manufacturing environment (with appropriate cabinetry);
- No contamination effects; (with appropriate shielding gas)
- Easily adaptable to virtually all types of control systems; and
- Minimal workholding fixturing is required because the process is non-contact in nature.

This paper discusses some of the basic characteristics of a laser beam, describes types of laser welding and cutting machines, and offers some performance data on commercially available systems.

Laser Beam Characteristics

Three properties of a laser beam -- narrow beam width, enormous intensity and coherence -- uniquely qualify it to be at the business end of sophisticated metalworking machine tools. Being nearly parallel and coherent (that is, all the emitted light rays are of the same frequency and radiate in "lock step"), the beam from a high-power laser can be focused down to a very small round "spot" only a few thousandths of an inch in diameter. This focused beam produces power densitites ranging between tens of millions to hundreds of millions of watts per square inch on the surface being worked. Such power is sufficient to melt or even vaporize the area of the workpiece on which the beam impinges. Welding or cutting is effected by inducing relative motion between the laser beam and the workpiece.

Types of Metalworking Lasers

There are two major types of lasers presently employed in industrial metalworking systems -- the Nd:YAG and the CO_2. The Nd:YAG laser emits at 1,064 nm while the CO_2 emits at 10,640 nm. Because of the ten times difference in wavelength, some materials readily absorb Nd:YAG laser energy and other materials readily absorb CO_2 laser energy (see Figure 1); however, there are materials which can be worked equally well with either Nd:YAG or CO_2 laser energy.

The Nd:YAG type is a solid-state variety whose lasing medium is a single crystal rod of yttrium-aluminum-garnet doped with neodymium. The lasing action is initiated by focusing the intense light from one (or more) krypton arc lamps onto the crystal via an elliptical reflective cavity. Nd:YAG lasers presently are available with power outputs anywhere from 50W to 1 kW.

The CO_2 type is a gas laser whose lasing medium is the CO_2 gas molecule. (Note: Because of the medium, the CO_2 type often is referred to asa molecular laser.) In this case, laser action is activated by an electric discharge in a partial pressure mixture of carbon dioxide (CO_2), helium (He) and nitrogen (N). CO_2 lasers are capable of delivering from 100W to 15kW of output power.

Laser Turnkey Systems

Three features of lasers make them conveniently adaptable to conventional machine tool mechanisms with computer numerical control (CNC):

- Laser output power can be automatically and precisely controlled;
- The laser beam can be easily manipulated by means of mirrors; and
- Laser materials processing is a simple, non-contact method of delivering high energy to a stable focal spot.

For these reasons, lasers can be easily integrated with CNC plasma cutting equipment, bridgeport-type mills (see Figure 2), CNC automatic punch press machines, CNC X-Y tables, diamond cutters (see Figure 3), robots or other production-line systems with dial feed tables or conveyors (see Figure 4).

Figure 5 shows a 2-kW CO_2 laser integ... with a CNC-controlled plasma cutting mechanism to provide five axes of motion for the laser beam itself. The laser beam is projected from the stationary laser to a 90 degree beam-bending mirror attached to the Y-axis gantry and is deflected at a 90 degree beam-bending mirror attached to the X-axis carriage.

Relative motion between the X-axis gantry and the Y-axis carriage provides for a total of 14 ft. x 14 ft. travel of the laser beam to the X-Y plane. The laser beam is deflected downward from the mirror attached to the X-axis carriage to a 90 degree beam-bending mirror attached to the Z-axis slide which, in turn, provides 2 ft. of beam motion on the Z-axis. The laser beam is rotatable about the vertical axis (described at the A axis) by rotation of the mirror attached to the Z-axis slide and represents the A axis.

As the beam exits the A axis, it strikes another rotatable mirror, which rotates around the horizontal axis (designated the B axis), and subsequently proceeds through the focusing lens to the workpiece. All these motions combine to provide for five axes of accurate high-speed CNC manipulation of the laser beam for the welding and cutting of wide variety of aerospace or commercial products that are diverse with regard to material, size and configuration.

The Welding and Cutting Process

Characteristics of a laser weld are similar to those of an electron-beam weld (see Figure 6). However, laser welding is not encumbered with a requirement for a vacuum environment around the workpiece. This attribute of laser welding means throughput can be significantly increased and the size of weldment that can be accommodated is not restricted to the inside dimensions of a vacuum chamber.

In welding applications using 2-kW of laser output power, full-penetration welds of various materials were made at the travel speeds listed in Table 1.

Cutting with a laser beam is accomplished using a high-pressure gas jet coaxial with the laser beam. Generally employed is a gas nozzle with a small orifice (approximately 0.050 in. in diameter) through which the laser beam can be focused.

Air, oxygen and inert gases, such as argon, often are used to aid cutting action (see Figures 7 and 8). When an inert gas is used, the cutting action is accomplished by a high-pressure jet blowing the vaporized and molten metal away from and through the cut kerf. When oxygen or air is used, an additional exothermic reaction takes place which enhances the cutting action, providing higher cutting speeds or permitting greater thicknesses to be cut. Typical cutting parameters using a 2-kW CO_2 laser are given in Table 2.

Applications

A good example of the 2-kW CO_2 laser's capabilities is provided by an application involving the gas-turbine XM1 tank engine manufactured by AVCO Lycoming (see Figure 9). This engine incorporates the use of a recuperator heat exchanger which requires 10,000 ft of weld per assembly. Presently, the recuperator is resistance-welded; however, serious consideration is being given to laser welding because it is a non-contact method and has higher welding speed capabilities than conventional techniques.

Recuperator plates made of 0.008 in.-thick Inconel 625 were welded together at a rate of 250 in. per minute using 1.5 kW of laser beam power (see Figure 10). The contoured weld path was provided by CNC laser beam motion.

Other examples of laser welding are shown in Figures 11, 12, 13 and 14. An example of laser cutting is shown in Figure 15.

Table 1 - Full-Penetration Welding Rates for 2-kW CO_2 Laser System

Metal	Thickness mm	Thickness in.	Speed mm/sec	Speed in./min
Stainless Steel	6.50	0.256	6.0	14
Stainless Steel	0.50	0.020	180.0	425
HSS/Carbon Steel	1.35	0.053	36.0	85
INCO 625	0.50	0.020	100.0	236
HSS/EN 47	0.75	0.030	130.0	307
Mild Steel	2.0	0.079	25.0	59
Mild Steel	4.0	0.158	7.0	17
16% Cr, 10% Ni Alloy	4.75	0.187	25.0	59
C263	3.40	0.134	11.5	27
HSS 188	2.00	0.079	40.0	95
Titanium Alloy	2.00	0.079	50.0	118
Titanium Alloy	1.00	0.039	50.0	118
Zirconium Alloy	3.00	0.118	13.0	31
H15 Aluminum	1.00	0.039	46.0	109

Table 2 -Metal Cutting Rates for

2-kW CO_2 Laser System

Metal	Thickness		Speed	
	mm	in.	mm/sec	in./min
Mild Steel	0.90	0.035	8.0	18.9
Mild Steel	4.20	0.165	4.5	10.6
Mild Steel	12.50	0.492	0.6	1.4
Stainless Steel	2.00	0.079	4.0	9.5
Stainless Steel	3.30	0.130	3.0	7.1
Stainless Steel	6.30	0.248	2.1	5.0
Invar	0.75	0.030	4.2	9.9
Zinc	0.50	0.020	4.5	10.6
Aluminum	1.60	0.063	2.4	5.7
Aluminum (Anodized)	1.60	0.063	2.4	5.7
Dural	3.50	0.138	0.6	1.4
Stellite 6	2.50	0.099	1.6	3.8
Cr/Mo	0.25	0.010	30.0	70.9
Titanium	3.50	0.138	0.4	0.9

Figure 1 - Shown here is a CO_2 laser cutting wood. This application is well suited to the CO_2 laser because its output energy at a wavelength of 10,640-nm energy is readily absorbed by fibrous materials.

Figure 2 - This universal, high-power metalworking system utilizes a 200-W pulsed Nd:YAG laser whose head is mounted on a bridgeport milling machine.

Figure 3 - This diamond cutting system is designed specifically to cut gemstones, most particularly diamonds. It utilizes a 50-W CW Nd:YAG Laser and an x-y translation table with an associated programmable computer which moves the workpiece under the laser beam.

Figure 4 - This is high-power CW Nd:YAG laser with six laser heads mounted on a common rail and six separate power supplies. Designed for materials processing applications, this system develops 600 W of continuous-wave (CW) power.

Figure 5 - Five-axes, microprocessor-controlled laser welding and cutting facility.

Figure 6 - Shown here is a 3-mm weld, produced at 30 mm/sec on 3-mm thick stainless steel produced at 30 mm/sec by a 2-kW CO_2 laser.

Figure 7 - This complicated geometric piece was cut out of a 0.125-in.-thick carbon steel plate with a pulsed Nd:YAG laser capable of producing an average output power of 400 W. This particular application required an output energy of 14 J per pulse at a pulse repetition rate of 12 pulses per second and a pulse width of 4 msec. To help the laser cut through the steel blank, oxygen under 40 pounds per square inch of pressure was introduced at the point on the surface at which the laser beam was focused. The pattern was produced by moving the steel blank under the laser beam via a computer-controlled x-y positioning table. Travel speed was 2.5 inches per minute.

Figure 8 - This photo shows the geometric piece of Figure 7 positioned in the cut out area of the steel blank. Note that the kerf width -- that is, the width of the cut -- is very small (about 0.015 inch).

Figure 9 - Serious consideration is being given to welding the recuperator plates of this gas-turbine XM1 tank engine with a 1.5 kW laser system.

Figure 10 - Recuperator plates used in the XM1 tank engine (see Figure 9) are shown here after being laser welded.

Figure 11 - CO_2 laser is shown here welding the inner race of a planetary gear.

Figure 12 - Shown here is a flange spot-welded by an Nd:YAG laser to a bimetallic heat sensor. Because a laser produces a very small heat-affected zone, it can be used in proximity to heat-sensitive parts.

Figure 13 - This relay can was hermetically sealed with a 200-W pulsed Nd:YAG laser.

Figure 14 - Shank-to-bit butt welds were made on these drills with a 600-W CW Nd:YAG laser system (see Figure 4). This procedure permits the manufacturer to use expensive alloy material only for the bit and relatively inexpensive carbon steel for the shank.

Figure 15 - This is an example of a circular saw blade cut out of a blank with an Nd:YAG laser.

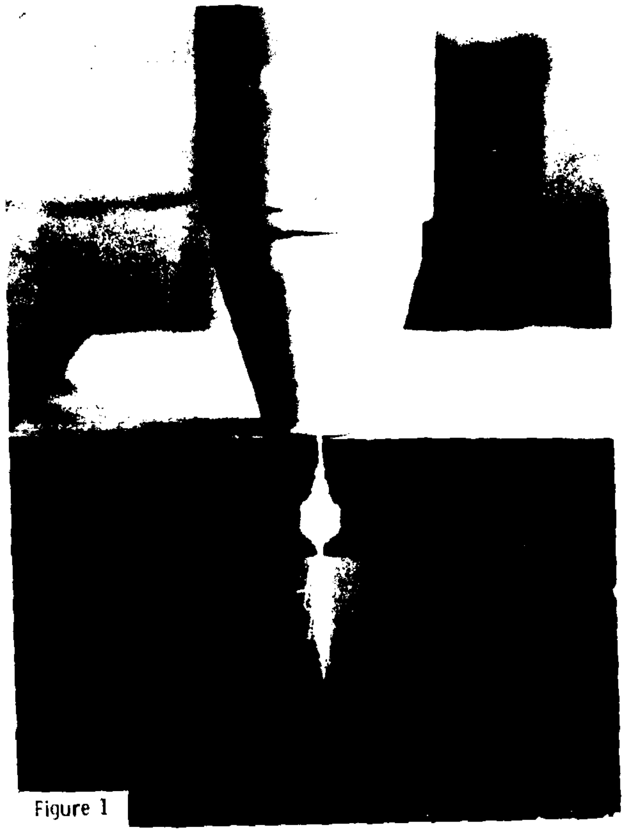


Figure 1

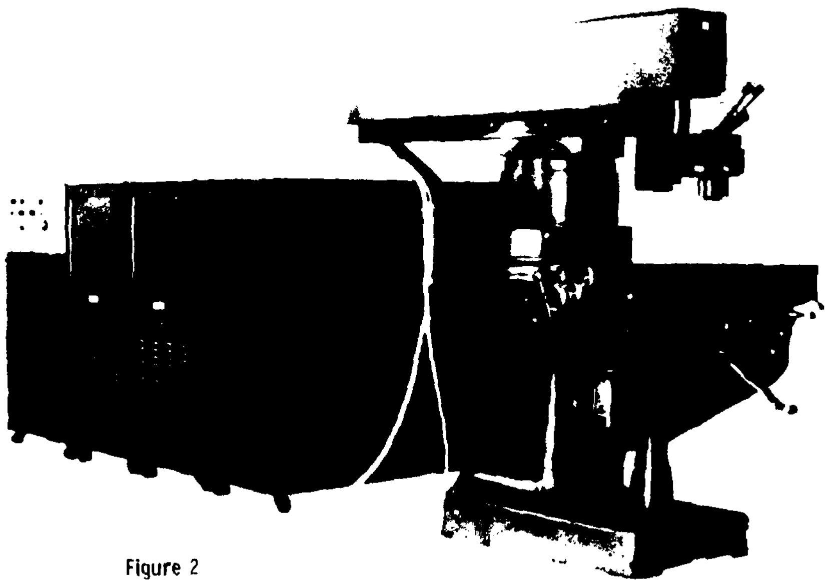


Figure 2

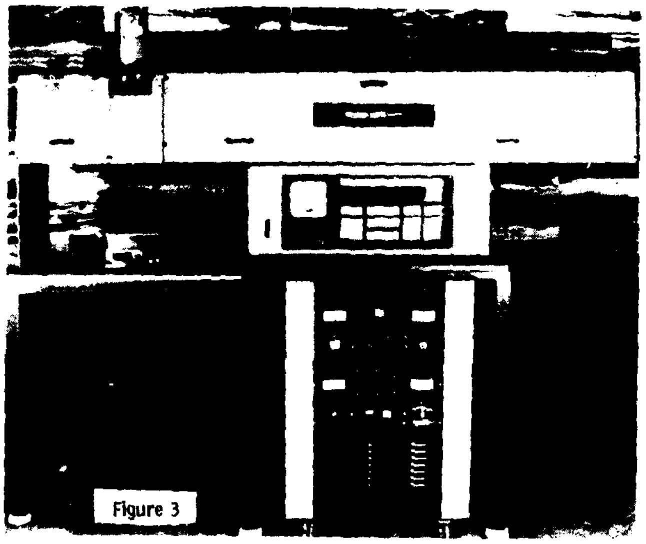


Figure 3

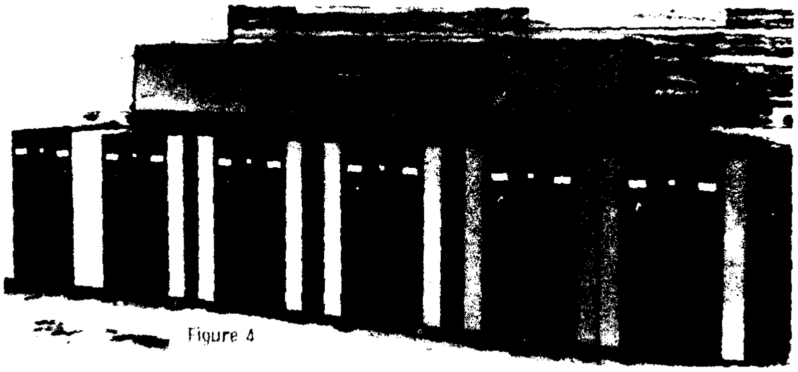
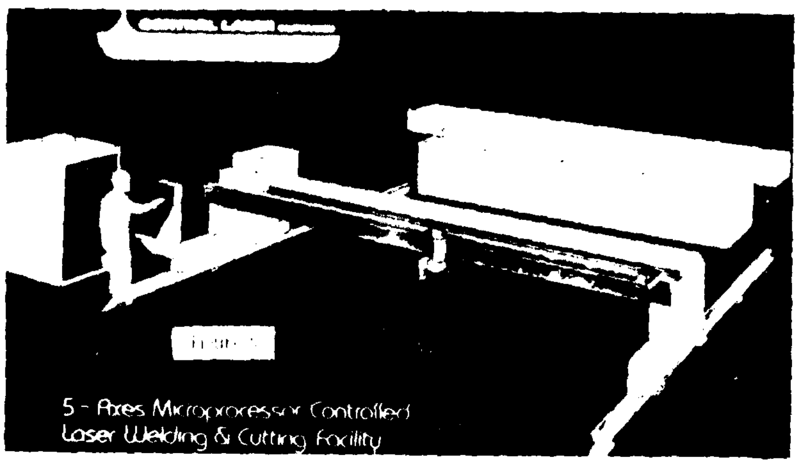


Figure 4



5 - Axes Microprocessor Controlled
Laser Welding & Cutting Facility

Figure 6

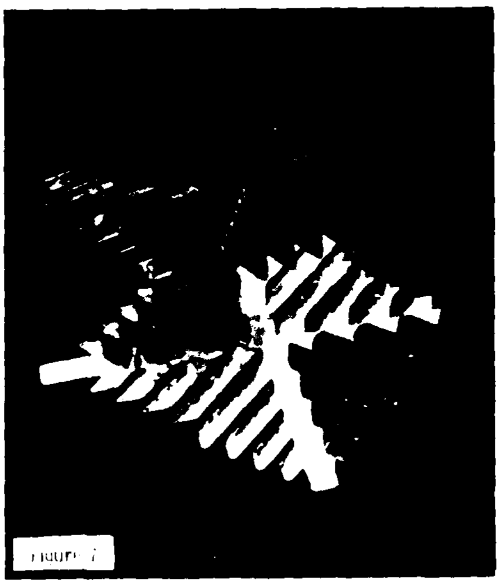


Figure 7

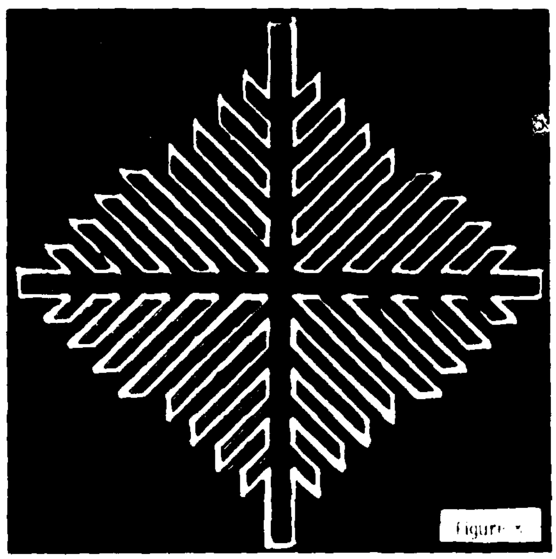
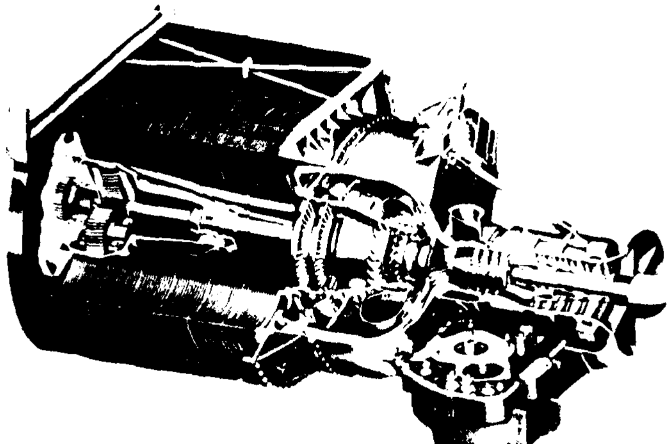


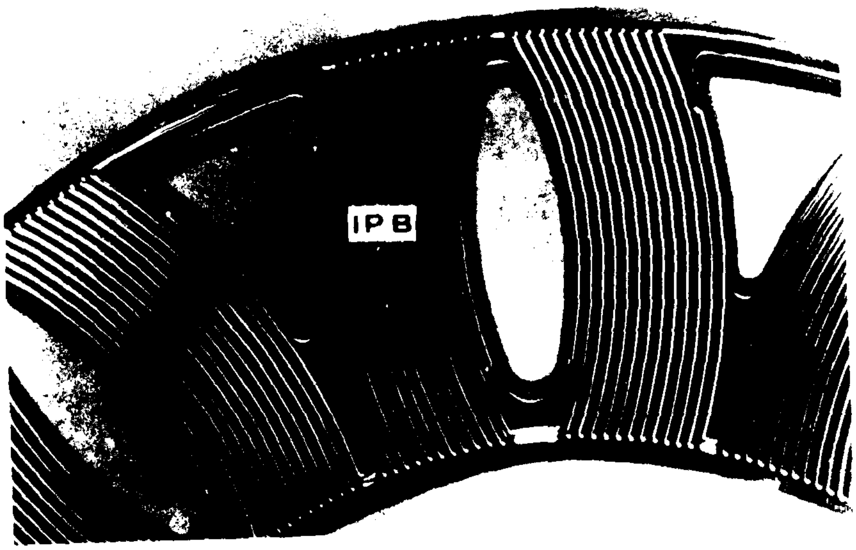
Figure 8



AVCO LYCOMING DIVISION

AGT 1500 TURBINE ENGINE FOR THE XM1 TANK

Figure 9



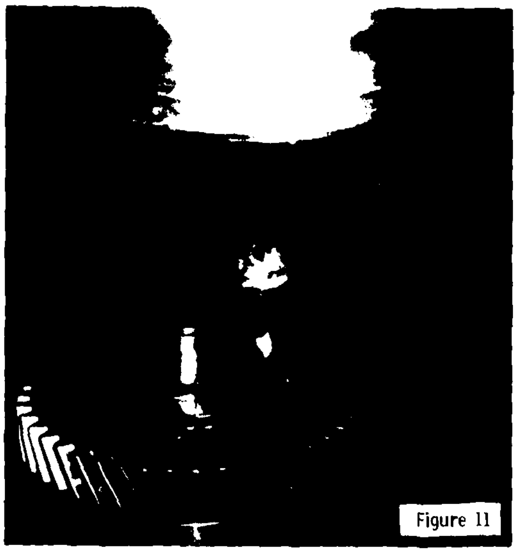


Figure 11

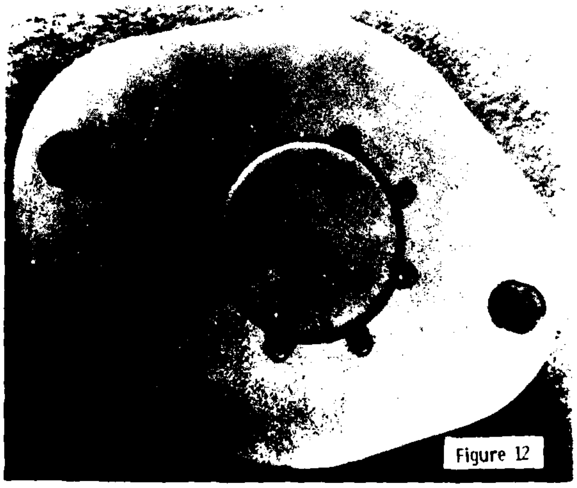
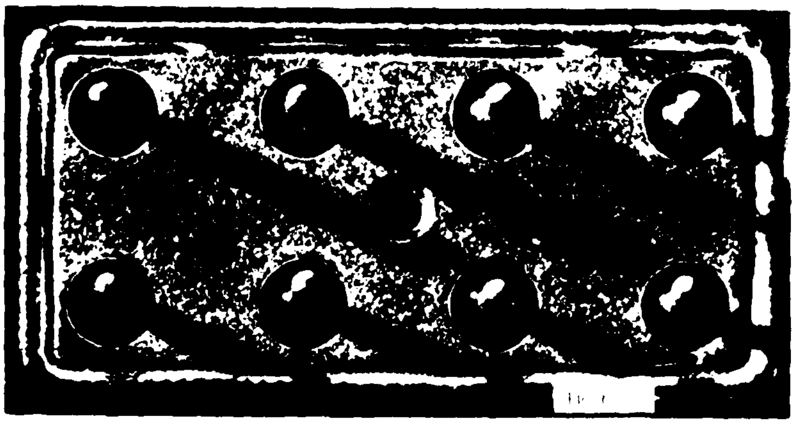


Figure 12



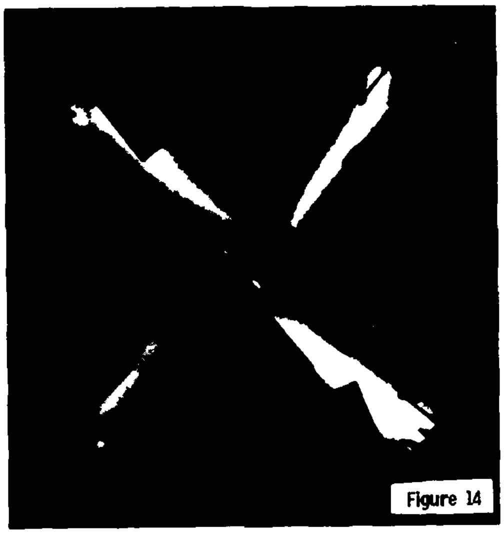


Figure 14

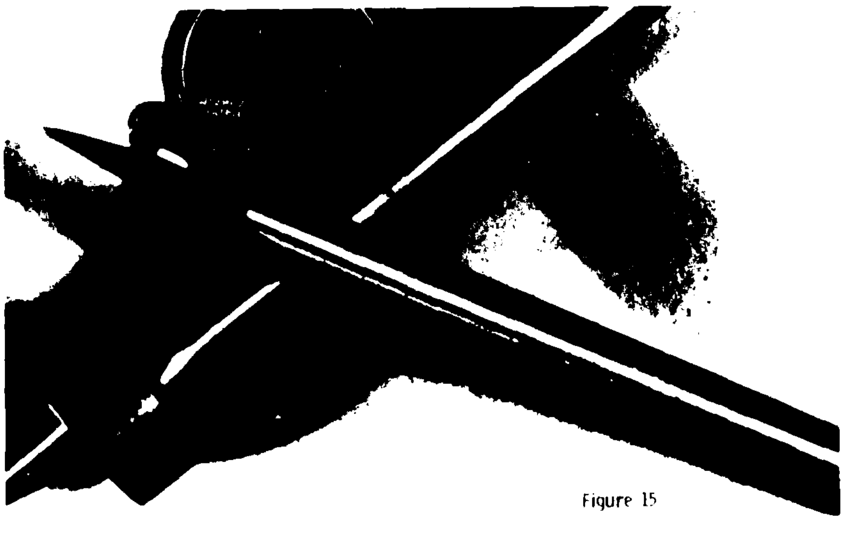


Figure 15

AMERICAN WELDING SOCIETY

by

MR. RONALD C. REEVE, JR.

President, Advanced Robotics Corp.

Mr. Reeve's presentation is unavailable for publication. A brief abstract follows.

The number of welders required, if current projections are followed, will increase by 23 percent by 1985 and 33 percent by 1990. The increases in particular industries is higher than the average; for example, the fabricated metal products industry will require 55 percent more welders by 1990. Because the welding environment is hot, smoky, and fatiguing, these numbers may not be attainable. One solution is to use automated arc welding robots. These robots do not replace welders, they increase the welders' productivity. Welding robots are specialized because they need high technology controls, they must operate smoothly, and they must be integrated into a complete production system. A major advantage of robots over conventional automated welding equipment is flexibility. The welding system can be easily reconfigured to weld many different parts and the failure of a single robot or small group of robots will not shut down the whole line. As an example, an 18-robot line operating under computer control arc welds six families of 33 different axle housings.

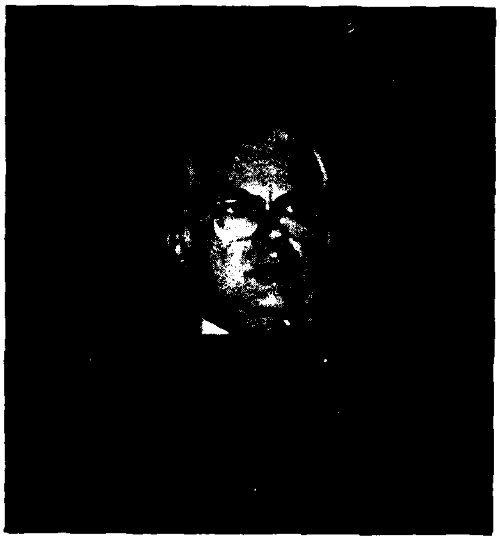
ELECTRONIC INDUSTRIES ASSOCIATION

by

MR. DALE B. HARTMAN

Corporate Director of Manufacturing
Hughes Aircraft Corp.

Presentation not available for publication



NUMERICAL CONTROL SOCIETY

by

MR. EDWARD J. TOTON

Immediate Past President, NCS
Senior Staff Engineer, General Motors Technical Center

NCS INITIATIVES IN EDUCATION AND TRAINING

Entering its third decade of existence, Numerical Control has been a paradox of application and acceptance. As a result the technology has fallen short of anticipated levels of use — particularly in small to medium-sized firms.

> "The NCS Mission is to achieve worldwide leadership in the promotion and diffusion of knowledge in the technical application of NC, CAD, CAM".

NCS has contributed to this mission over the last 17 years, through a worldwide network of chapters, a variety of seminars and training programs. At the AMTC alone over 75 technical papers are presented.

NCS has found through a 1978 survey that a minimum of 22,700 small and medium-sized manufacturing facilities who did not have any NC, could profitably use Numerical Control Technology. Unfortunately, the majority of these companies did not plan to invest in NC in the near future.

Survey findings indicated a series of simple questions that a small or medium-sized company could review quickly to determine if their operation represents a likely candidate for NC technology, (see figure 1).

FIGURE 1

The combination of any three of the following conditions means NC can be successfully implemented:

More than 25% of the parts can be grouped in families

More than 25% of the parts require three or more speed/feed changes within a single setup.

Parts with contours are defined by mathematical equations.

Typical lot size is less than 50 pieces.

More than 25% of the parts contain contours that are not lines and/or circles.

More than 25% of the parts contain compound angles.

Average setup exceeds 3 hours.

More than 25% of the parts have dimensional tolerances less than 0.001 inch.

Typical part design is changed more than 5 times per year.

Applying the test to the survey participants indicated that approximately 8,000 of the over 22,000 companies possess manufacturing characteristics similar to companies currently successfully utilizing NC technology.

It does not take much imagination to predict the productivity improvement that would be possible if these companies were to take advantage of today's technology in numerical control.

The survey also asked participants to cite events that would have to take place before (A) Nonusers would employ NC and (B) Users would significantly increase their usage. Justification was sited as one of the primary importances. This means that a plant considering the acquisition of NC equipment must develop — or be helped to develop — an ability to conduct a proper justification analysis. (Financial, personal, etc.)

The availability of properly trained people possess another serious concern. The National Machine Tool Builders' Association (NMTBA) estimates that there will be a shortage of 20,000 technicians - annually - in Numerical Control over the next 5 years. That's 100,000 people that will be needed but unavailable. Another estimate, there will be 10,000 NC programmers short each year til 1985-86 — and that is 50,000 programmers also unavailable. What is being done about this situation?

The newly formed NCS Institute is responding to education and training needs.

On October 7, 1980 at Cleveland, Ohio the Numerical Control Society Institute (NCSI) began the first in a series of NC training courses, "NC Concepts and Fundamentals of Programming". The thirty hour course will span ten weeks, with 45 people participating.

This course is a part of the NCSI's Training Program that consists of a series of courses for training NC programmers and NC technicians for maintenance support. The program structure is the "NC Concepts . . ." course followed by the Basic Programming (Programming 1) course, than branches to parallel courses for either a programming or maintenance specialty (two or three 30 hour courses per specialty). A "NC Management" course, is optional to complete the program.

The NC Training Program will be extended to at least two more cities by early 1981.

The NCS education institution survey conducted last year identifys some alarming information. Only 12 colleges or universities offer a bachelor's degree (4 Year) and 82 schools offer associate degrees or certificates (2 Year), related to manufacturing technology. Compare this with 7 times —— over 550 —— the numbers of institutions, that offer associates and bachelor degrees in computer science. It is obvious that we have a long way to go in education regarding manufacturing technology.

Another alarming fact is that the curriculum varies considerably from school to school. Thus graduates from one school perform on a different level from those of another school.

To eliminate this situtation NCS is developing a set of competency standards and curriculum guidelines for colleges and universities either not yet involved with NC/CAD/CAM or to assist upgrading existing programs so students will be able to meet certain standards and perform tasks required by industry.

This year we will conduct an industry-wide survey to determine industry's specific requirements. This information is vital to our recommendations for curriculum and development of competency standards.

To assist the NC user in hiring qualified programmers, and to enable programmers to evaluate their skills, NCS is offering a certification program for NC programmers. Three categories of certification are available. Each category certifies the programmer's skills related to programming ability based on the complexity of the part/workpiece geometry. The main advantage of NC programming certification is that it indicates ability to meet a certain set of implied standards. These standards consist of anticipated requirements in academic and experience areas that provide proficiency in NC programming.

Furthermore, to verify that the holders of NC programming certificates have kept abreast of new developments in NC, re-certification is required every three years. Through completion of a home study course, and a minimum number of points earned by attending seminars, courses, writing articles, etc.

NCS certification program is being expanded to include NC maintenance and management.

Training, education and certification are being accomplished through the NCS Institute.

Additionally, NCS advocates the establishment of an NC demonstration center. The center would assist users and potential users to evaluate, justify, implement NC systems and provide training.

The Center would provide companies considering the purchase of NC equipment, the first or expansion, an opportunity to:

1. Work with the Center's staff to prepare a part program.
2. Machine the Part
3. Assist in the formulation of generic specifications for the NC machine tool capable of producing the part types desired.
4. Provide for training —— technician, operator, and programmer

An opportunity to decrease cost and to increase productivity of NC equipment if represented by the ability to exchange part programs between NC control units regardless of control brand or machine type. This can be achieved if a standard CLDATA Input Format is accepted for an increasing number of Computer Numerical Control (CNC) control units with on-line post processing capabilities.

Expected benefits of a standard CLDATA Input Format are:

1. Part program inventory reduction to one per job.
2. Operational flexability to allow flow of job to any machine available within a facility without post processing the part program for a different control or machine. This is an important feature when a machine goes down and the job is high priority.
3. Improved coordination with subcontractors allowing part programs to flow back and forth depending on production requirements and availability of facilities.
4. Enhance military preparedness posture, with the ability to transfer CLDATA to other manufacturing facilities without reprogramming or post processing.

NCS hosted a meeting on August 7, 1980 at Fairchild Republic, to determine the NC user communities interest in accomplishing exchangability of NC part programs. Fairchild demonstrated their capability for accomplishing exchangability of CLDATA between controls regardless of control brand or machine type. Currently 18 companies including Fairchild Republic, Martin Marietta and Rockwell International are using this concept in production.

EIA IE-31 (Numerical Control) Committee has established a project (PN 1456) to develop a standard for exchangability of CLDATA Input Format to numerical controls. In parallel with the formal standardization activities NCS will publish technical specifications with examples, expected benefits, etc., to gain acceptance within the NC user community.

NCS supports the following ongoing funtions:

1. Providing a source for current state-of-the-art information through an annual technical conference, numerous educational courses, seminars and publications and local chapter charter programs.

2. Publishing the latest technical information in the newsletter, journal, and proceedings.

3. Acting as an outlet for "public domain" information and software.

4. Representing the NC/CAD/CAM concept in government programs directed at manufacturing technology.

5. Establishing certification guidelines.

6. Improving educational opportunities including the support of student chapters.

NCS is cooperating with others to further implement NC/CAD/CAM, by reporting on the activities and projects of CAM-I and other related organizations and where possible work with other groups to attach problem areas.

—— Assist Program Development for the DIPEC Annual NC Workshop

—— Serve as Secretariat for ANSI X3J7 for APT Language

—— Cosponsor of the ICAM Industry Briefing, September 29 - October 1, 1980 in St. Louis

—— Participate on MTAG Executive Committee and Annual Meeting.

In particular, NCS financed the reproduction and distribution of the US Army's excellent study of NC Lathe Languages. In December 1979 a special news conference was called to announce the findings and contents of the report. Eight trade publications have published major articles on this report during the past 10 months. A seminar on NC's Language selection was presented in February at Chicago. The foremost benefit of this study was that it provided a guide and methodology for each company to use in selecting the right NC language for its production requirements.

NCS encourages more studies of this type. In particular the NC machining center language evaluation published 6 years ago needs updating . . . over 1,000 copies have been distributed to date and it's presently out of print, and much of the material is outdated. Also a study of NC graphics systems would be extremely timely.

At the time NC was developed by the U.S. Air Force and the MIT project back in the early 1950's, few people visualized NC going beyond the machine tool, but both NC and the computer have improved over the past score of years and the computer has been applied to many design and manufacturing tasks beyond that of generating NC information. It is quickly, being realized that the computer, not numerical control itself, is the key to the new manufacturing revolution, and we visualize the Numerical Control Society entering the 1980's as the focal point for total computer aided manufacturing.

Developing technology is only part of the job. Gaining acceptance and committment to implementation is the real challenge.

Programs must be presented and information published to explain separate system modules that will eventually be linked together to comprise a total CAD/CAM system. Also standards must be established for the interface between engineering and manufacturing to allow implementation of individual systems today with easy cost effective integration tomorrow.

To this end NCS last year began establishment of CAD and CAM Chapters in addition to the NC chapters already in existence. Each major segment is providing an opportunity to come together to focus on its immediate area(s) of concern, NC or CAD or CAM. In other words, integration of these technologies will take place, but the manufacturing industry in general must implement within the framework of a dynamic long range CAD/CAM plan.

It's been said that manufacturing technology is the answer to the decrease in skilled personnel. This is misleading. Technology such as NC was to fill the void of skilled machinists. NC could and should alleviate that problem however, it has created problems of its own. It depends on ones definition of skill, but new

technology brings the need for educating and training people to support that technology. Is it skill or knowledge? . . . It is a combination of both! Educated and trained people equal profitable, efficient utilization of new technology.

NCS is committed to providing the required education and training for NC, CAD, CAM and to promoting the successful implementation of these technologies for increasing productivity in the worldwide marketplace in which we live.

NATIONAL MACHINE TOOL BUILDERS ASSOCIATION

by

MR. JOHN B. DEAM

Technical Director, NMTBA

The phrase "Productivity Growth in the '80's" has appropriately been selected as the theme for our MTAG Conference this year. That phrase, however, could represent a question about the direction our national economy will take in the years ahead or it could be the basis of a statement of national purpose which each of us, individually and collectively, adopts and pursues with determination. As was intended, the phrase must indeed represent a statement of national purpose. This is especially true because of figures recently released by the U.S. Department of Labor, Bureau of Labor Statistics, on productivity within the manufacturing sector of our economy. The report shows that in the second quarter of this year, productivity dropped 1.4% compared to a year ago. Even more alarming is the fact that from the first quarter to the second quarter of this year, productivity in the manufacturing sector dropped by a whopping 4.5%. The challenge is clear. But what affects productivity? What part does manufacturing technology play? And, how can, and are, those of us here today able to help in reversing this downward trend?

First, productivity is a result of the joint effect of many influences including new technology, capital investment, the level of output, capacity utilization, energy use, managerial skills, as well as the skills and efforts of the work force.

In particular, we might highlight the fact that productivity grows with increased training, education and motivation of the work force. It grows with a better working environment. It grows with a healthy, well cared for work force. Particularly important for those of us here today, it grows with better machinery and equipment with which to work, and it grows when more highly developed technologies are employed. And not to be overlooked or underestimated in importance, productivity grows with efficient, effective management at the helm. Some people might even argue that improvements in the other areas are of little consequence if effective leadership is lacking. As evidence of this, we can look at the productivity of a number of U.S. manufacturing plants where effective, motivated new leadership has turned losers into winners.

Yes, each of us, individually and collectively, can positively influence every one of these factors for ourselves and for those who work for us. But let's turn our attention to the two productivity influencing factors which are the specific subject of this conference, namely the machinery and the technology. In particular, I would like to address the machine tool related part of machinery and technology.

This machine tool field is of fundamental importance to the industrial base of our nation. It provides the basis for the production of everything that is manufactured, whether it be for civilian consumption or for our military preparedness.

It is, of course, with machine tools that all the other machines for the production of goods are made. In spite of this importance to the conversion of items from raw materials into finished products, machine tool sales account for only about 1/6 of 1% of our Gross National Product. For that reason, machine tools may be overlooked in our attempt to focus on the most important aspects of the manufacturing technology involved in productivity improvement. I hasten to point out that if we still used the primitive lathes and other machine tools of yesteryear, we would still be attempting to preserve the peace with armaments of that same vintage. And, while we do have vastly improved weapons systems, and other implements to preserve the peace, one can't help but speculate about improvements in cost or quality that these systems might have if both industry and government replaced their aging machine tool inventory with machine tools having new productivity improving features.

Let's review some of the productivity improving features being offered or developed by manufacturers of machine tools and related equipment and systems.

First, increased overall productivity can be achieved by a number of different but somewhat interrelated efforts. Productivity can be increased by reducing the time required for the initial design of manufactured products and also by reducing the time required for redesign or change. Such speed-ups will allow critically short design talents to be redirected to additional design tasks, or will allow earlier implementation of design improvements or product feature enhancements.

Better process planning will, of course, improve productivity. It will do this through more efficie use of processes and/or machines, and through the use of routings specifically tailored to the chara teristics of the raw stock and of the finished workpiece. In the larger sense, better process planning can be construed to include taking advantage of optimized interrelationships within the entire manufacturing environment. And this makes for improved productivity.

Reduced inventories are another factor in improved overall productivity (Recall that productivity as reported by the Bureau of Labor Statistics indirectly considers, among other things, the efficient u of capital).

Productivity is certainly improved by the use of faster metal removal or forming rates. Of course, depending upon the complexity and size of the part, the metal cutting or forming times may be small compared to the total time that the part is in the manufacturing environment.

Often as, or more, important to improving productivity than reducing metal removal and forming time

is reduction of the time consumed between sequential cutting or forming operations. This area also has been addressed by the designers of new equipment and processes.

Finally, overall productivity can be enhanced through the use of automated inspection techniques and procedures. Such procedures limit the passage of bad parts to subsequent operations, thereby saving valuable downstream manufacturing and/or assembly time. It also reduces the incidence of premature field failures and the attendant loss of customer confidence.

As an adjunct to the direct benefit of increased productivity, some of the manufacturers of equipment are producing improvements that concurrently produce better parts. Better parts may result because of the availability, at no increase in manufactured cost, of parts with tighter tolerances. This might allow interchangeability of parts which previously had to be specially selected to fit or had to be matched with other parts. Better parts might also result from improvements in surface finish, which in turn might eliminate subsequent operations or might at least improve customer satisfaction.

We should look now at some specific examples of productivity improving efforts that have been undertaken by the designers of manufacturing related systems and equipment. We can easily do this with an abbreviated review of equipment displayed at the most recently held International Machine Tool Show. This show was held last month in Chicago and is sponsored by the National Machine Tool Builders' Association.

By way of introduction to this displayed equipment, let me first mention a few items of possible interest concerning the overall content and size of the show itself.

The show has grown considerably in size and scope since 1927 when it was first held. Even when comparing the recent show with that held 20 years ago, when numerical control was formally introduced to the manufacturing community, the show has greatly expanded in size, and in the technical sophistication that has been exhibited.

This year the show drew a crowd of nearly 106,000 people who came from all over the world to see nearly 800,000 square feet of exhibits in three locations, namely at McCormick Place-East, McCormick Place-West, and at the Conrad Hilton Exhibit halls. For those of you who attended the show and ended up with tired legs and sore feet, you might be interested to know that the exhibits covered an area equal to 50 football fields and that there were about 7 miles of aisles.

All told, there were 1,143 exhibitors that moved in and out about 18,000 tons of machine tools and other equipment, accessories and displays in 9 days. The total value of this equipment was over $100,000,000. Needless to say, much that was new was on display and an abbreviated recounting could not cover everything of importance. But let's look at a few of the productivity improving items that were there.

Recall that one of the ways a firm engaged in manufacturing can increase it's productivity is to reduce the design time required for the products that it manufactures, and to reduce the time required to implement engineering changes whether these be required because of new customer or market requirements, or because of engineering or manufacturing reasons associated with the current design. The specific ways in which design time and engineering change time has been reduced include an increasing use of interactive graphic systems, the use of computer based application programs for design and engineering problem solving, and the use of high speed plotters for the generation of engineering documentation.

Many interactive graphic systems were in evidence at the International Machine Tool Show with varying degrees of sophistication. These systems, which allow the designer to sit at a console and input design information through a keyboard or light pen, can be used to design both two dimensional and three dimensional parts. Many systems allow for operator initiated addition of various features from a pre-established data base, for the changing of drawing scale, for the rotation of the part image about any axis, for the automatic generation of secondary and tertiary views of the part, and on and on. The design and drafting rooms in today's plant need not look anything like those of years past, where wooden drawing boards with Tee-squares and triangles were the order of the day.

Such interactive graphic systems often provide for the inclusion of design application programs, or such programs can be utilized on separate computers or time shared terminals. Application programs are available for gear train and transmission designs, for structural designs, for bearing designs, for servo mechanism analysis, and for the design and anlysis of virtually every sub-system of the modern machine tool.

New and more powerful systems for the generation of part programs for use by numerically controlled machine tools were also in evidence at the show. Such systems can provide varying degrees of help to the part programmer, from help with solving simple two dimensional trigonometric problems to solving complex geometric problems encountered on multi-axes milling machines.

Also seen at the show were improved versions of part programming systems which utilize the human voice for input. While these systems have been demonstrated before, improvements in capability and

reliability were in evidence.

As mentioned previously, the use of automatic high speed plotters in conjunction with either computer-aided design systems or ' .ijunction with part programming systems, provide a rapid and precise record of engineering d. .igns and part program commands.

Individual pieces of equipment for better process planning were also shown at the International Machine Tool Show. These pieces of equipment provide for the automated selection of part routings, optimization of feeds and speeds, and the number of cutting passes required. As a broader part of the effort to improve process planning, it should be pointed out that completley integrated manufacturing systems were on display. These systems included ones which encompass everything from computer-aided design, to computer-aided process planning, to computer-aided part programming, and finally, to computer-aided manufacturing. Some systems provide a common data base for design and manufacturing operations. Other systems involve the integration of a number of machine tools into a single manufacturing entity, with automated materials handling equipment providing a common link. The highlight of these systems is the variable nature of the tasks that can be performed and the fact that these tasks can often be undertaken with little human intervention on the shop floor. One system displayed at the machine tool show incorporated the use of driverless carts which would shuttle materials and tooling from machine to machine so as to maximize through-put.

Many of the innovations just described result in the need for inventories of smaller size than were previously required. Inventories of raw material, work in-process, finished goods and even tooling can all be reduced by effective computerized decision making such as is now possible. We are at the point where computerized manufacturing control is successfully complimenting the previously available computerized material requirements planning (MRP) systems.

Certainly one feature of the exhibits at this year's show was the ability to remove or form metal at faster rates. These increased abilities are due not only to the more exotic cutting materials that are currently available but also due to the higher speeds now obtainable in the machine tools using these cutting materials. Of course, faster tool changes mean less time that each piece must be on the machine. Cutting tools displayed at the show allow increased depth of cuts, faster speeds and, in some cases, provide for increased life of the tooling.

Recent research in the fields of bearings and lubrication have allowed for increased spindle speeds, and a better understanding of the dynamics of mechanical systems has allowed such machines as punch presses to increase metal forming rates. Punch presses with the ability to stamp out over 1,500 pieces per minute are now routinely available for smaller workpieces.

Recently, the laser has made inroads into the metal cutting and forming fields. Currently a number of machine tools are available where sheet metal parts may have contoured shapes cut in them using the material cutting capability of a laser. Such machine tools eliminate the need for develo ing contoured cut-outs or large cut-outs by the previously used method of repeated punching with a relatively small punch. Laser cutting techniques have been developed which result in a contoured edge that often requires no further finishing operation.

Perhaps more important than the increase in metal removal and forming rates is the work that has been done in reducing the non-cutting or forming times of parts within the shop. This nonproductive time has been reduced by improvements to the loading and unloading operation. These improvements include the use of faster acting manually controlled material handlers, as well as the use of robots. Reduced non-cutting time is also provided by quicker changeover of existing tooling, is provided by faster rapid traverse rates, and is provided by faster tool changes between cuts.

At least one loader/unloader on display incorporated the ability to automatically turn a part over for the start of second operations.

A number of robots were shown, at least one of which incorporated the ability to trace a moving target such as the point on a moving conveyor belt, and through infrared "eyes" could sense the location of a part to be picked up.

Quick change jaws were the feature of at least one chuck on display thus making it less time consuming to change the workholding configuration from one workpiece to the next.

And finally, innovative new drive techniques were displayed which allow machine tools to move at faster, better controlled rapid traverse rates. Extensive use is made on today's machine tools of DC electric servo drives, some of which incorporate the use of brushless DC motors for improved reliability and reduced maintenance. Also, drive systems are used which employ both the more customary SCR type power amplifiers, and the pulse width modulated drives incorporating either power transistors or power SCR's. Today's technology also makes possible the driving of various machine tool elements by variable frequency AC drives. Such frequency systhesizers are of relatively new vintage in machine tool sizes.

Automated inspection techniques, without a doubt, provide increased productivity on the shop floor.

Such techniques might involve in-process gauging, or on-the-machine inspection (but not necessarily during the machining process), and finally, computerized off-machine inspection. A number of both contact and non-contact type inspection devices and systems were displayed both separately and as parts of machine tools. Increased accuracy and speed of measurement were featured.

A relatively new inspection probe was displayed which can be mounted in a conventional toolholder and called into play whenever the part programmer desires to have the part inspected. Wireless techniques are used for transmitting the inspection data back to the control system for either manual or automatically inserted tool offset corrections.

Computer controlled coordinate measuring machines capable of inspecting complex contoured parts are now available in a variety of forms. And additionally, the use of lasers has penetrated the field of individual part inspection as well as being previously used during the construction and alignment of complete machines.

The ability to produce better parts is with us also. Such better parts are being produced through the ability to hold tighter tolerances, which in turn are possible because of stiffer machines and increased machine accuracies. One machine tool on display which offered increased stiffness was one in which the column was filled with concrete -- a simple but effective innovation to reduce vibration.

Often improved surface finish is a naturally occurring by-product of such stiffer machines and the use of highly improved vibration analysis techniques has made the job of designing rigid, non-vibration prone machines all that much easier.

All told, many new and creative products and systems were presented for the visitor to view. Truely, productivity enhancing machines, equipment, systems and know-how are, and are becoming, available for increased use by the U.S. manufacturer. We must do our best to see that these are fully utilized.

Unfortunately, however, there are some productivity growth inhibitors which we must recognize, and help correct before we can be fully effective in putting these and future productivity improving ideas to work.

One of the things that is a productivity growth inhibitor is the proliferation of federal, state and local government rules to which each manufacturing company must adhere. These can detract from, or dilute, our nation's productivity increasing efforts. As an example, complying with such regulations may consume limited funds that could otherwise go toward the purchase of productivity improving equipment. It has been reported that in the last four years alone the number of pages in the Federal Register devoted to rules and regulations has increased by 35%, and according to a study by John Kendrick of George Washington University, the proliferation of government regulations accounted for approximately 13% of the decline in productivity growth rates during the middle 1970's.

Second, it should be pointed out again, that an important source of productivity growth is the application of new technology to the production of goods and services. More than half of the productivity growth during the 30-year period from 1948 through 1977 came from this single source. But, technological progress is fueled by capital outlays for formal research and development, and as a nation we have been spending less on R&D nearly every year since the mid-1960's. In particular, the percent of each sales dollar devoted to R&D in the total machinery sector of our economy averages 1.6%, even though machine tool R&D has averaged about 4% since 1975.

Technological progress is also affected by the purchase of new capital equipment. Since new capital equipment embodies the latest technological advances, capital spending tends to spread productivity improving technology throughout the economy.

Third, in general, the more capital investment associated with each man-hour of labor input, the greater the output, and that is productivity improvement pure and simple. Obviously, a man using a numerically controlled lathe can produce better and a greater number of parts than one using a lathe powered by a foot treadle, or even a power driven lathe that is hand operated.

It seems that these inhibitors to productivity increases must be addressed as part of our national commitment to productivity growth.

Let's return then to the inferred premise of the conference, namely that productivity growth in the '80's is to become a national commitment. Such a commitment must be based upon a multifaceted plan.

Surely part of this national productivity commitment must entail an encouragement to save, for it is through savings by each of us that monies become available, as loans, for such things as the acquisition of productivity improving equipment.

Having acquired the savings, we must further encourage investment of those savings specifically in productivity improving equipment, examples of which we have seen and talked about during the course of this presentation. Certainly, the adoption of some form of accelerated depreciation schedule for capital equipment would encourage this increased investment. A program of 10 year/5 year/3 year

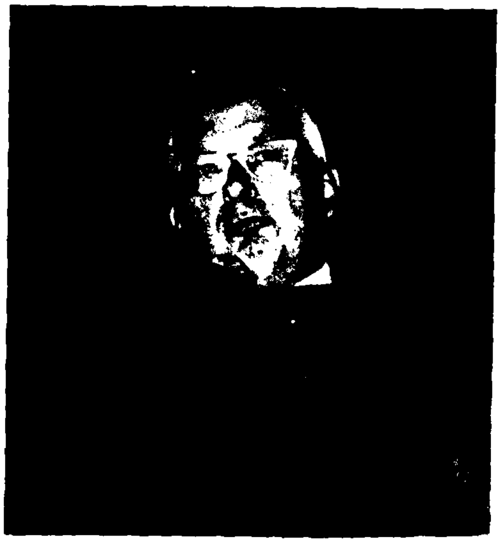
write-offs would be an example of this type of legislative inducement.

Thirdly, as part of our national commitment, we must spur investment by U.S. firms in increased research and development, for it is through these programs that new technology is created and made available to the products of the future.

Next, we must temper government regulation with reasonableness and look at the cost benefit trade-offs of both proposed and existing regulations. And finally, we must commit ourselves to training, and indeed inspiring our work force to achieve our national productivity growth goals.

That then is a program of national productivity growth that is offered as a challenge -- a challenge for each of us, individually and collectively. It's a challenge that will take us further from the machine tools and the machinery which were treadle or overhead belt driven, to the days of tomorrow with computerized control of each of the various segments of the manufacturing activity. Through this achievable program of productivity growth we can increase our national output and stem the tide of rising prices. We can increase the living standard of each of us, and put more of our nation to work for the good of all mankind.

There must be this commitment to national productivity growth, a commitment which will help keep the U.S. at the forefront in this world of diverse nations. It's only through such commitment that we can remain a bountiful supplier to the needs of our people, and a strong protector of world peace.



SOCIETY OF MANUFACTURING ENGINEERS

by

DR. JOHN F. KAHLES

Quality Assurance Council, SME
Senior Vice President, Metcut Research Associates Inc.
Director, Machinability Data Center

The Society of Manufacturing Engineers (SME) is most pleased to have been invited to participate in MTAG 80. This meeting and those held previously provide an unusual opportunity to transmit to SME's 53,000 members a perspective of DoD's future needs and goals.

Response to information gained at these annual MTAG meetings comes to SME's technical committees, groups which closely match MTAG's Subcommittee structure. For example, matters relating to quality are handled in SME's Quality Assurance Council (QAC), a direct counterpart to MTAG's Test and Inspection (T&I) Subcommittee. During the past several years SME was represented on the Test and Inspection Subcommittee, thereby gaining first-hand knowledge of the broad range of MTAG's T&I Subcommittee.

Based upon experience gained by participation in these committee functions, this year SME has chosen to highlight some of its concerns regarding Quality Technology. In offering its suggestions, SME is well aware that the subject of quality is much too large in scope to be addressed in great depth in a short presentation. Therefore, this discussion is limited to identifying a few broad areas which merit consideration and to presenting some of SME's work in the quality arena.

The Cost and Production Environment in the USA

Historically, the major thrust in manufacturing in the USA has been directed toward achieving high rates of production at low cost for a great variety of products. Quality was certainly not totally neglected, but when delivery or costs were in danger of slipping, quality was frequently relegated to second place. It is important to note that the heritage of this practice is still with us at a time when we can no longer treat quality matters in the same fashion. It appears clear that in the eighties quality considerations must gain greater visibility in all areas of manufacturing technology in the USA. Some of the forces causing change are all too familiar--product liability, warranty costs, OSHA, EPA, and the achievements of international competitors, notably Japan. It would seem that DoD has an opportunity to help erase our traditional environment in which quality has all too frequently been forced into the background. A careful management review of Japan's success may be helpful.

Japan's Turnaround

Considerable publicity has been given to the successful quality programs in Japan and to the important roles played in these programs by US consultants such as Dr. J. M. Juran and Dr. W. Edwards Deming. Japan changed its approach to quality by well-thought-out management concepts. The teamwork concept and direct involvement of nonsupervisory personnel in quality circles were just a few of the innovations employed. At the present time there are questions being raised concerning applicability of the Japanese approach in the USA. There is, however, little question that Japan's methods deserve very careful study by DoD, perhaps through MTAG's subcommittees.

Quality Technology--A Need for Greater Visibility

In certain industries and also in the Air Force Systems Command (AFSC) steps have been taken to help Quality Technology keep pace with advanced engineering and manufacturing technology. Recently, at the request of AFSC, the Aerospace Industries Association of America, Inc. (AIA) and the National Security Industrial Association (NSIA) completed the study titled "Q-TECH." Specific recommendations of this study included: "(1) an increased administrative emphasis on Q-Tech projects, (2) an enlargement of the scope of current technology applications activities to address more specifically overall quality and reliability assurance needs, (3) an increase in the level of annual funding on necessary, cost effective projects offering high probability of success, and (4) the initiation of certain assurance technology programs starting with five high payback projects identified as key problem areas requiring near term resolution for immediate application to current Air Force programs."

SME views the findings of the Q-Tech Committee as a fine first effort toward helping DoD properly manage new and increased quality concerns.

Quality Technology and the Computer

One of the most significant trends in the quality field is the broad and varied application of the computer in manufacturing. The computer is well suited for automation of the labor intensive, highly repetitive testing areas in manufacturing. If there has been too much separatism of Quality Technology and Manufacturing Technology, the computer is slowly drawing the two technologies together by the increased application of highly automated in-process controls, advanced data handling systems and high speed final test and inspection equipment. In fact, the application of the computer in engineering design is already bringing quality into the picture at the conceptual stage of product manufacture. While these trends are desirable, they do raise the following point of concern to SME: the possible diffusion of the authority of quality departments. SME believes that Quality Technology must have high visibility and must maintain a high level of authority in the organizational structure of industry and government.

MTAG's T&I Committee Activities

SME is pleased to endorse the action of the T&I Committee of MTAG in its efforts toward expanding its coordination with industry. Its first joint conference with industry covered the subject of "Dimensional Measurement in Manufacturing." The technical program was developed in the T&I subcommittee by R. Rowand of the Air Force Materials Laboratory and was sponsored by SME. SME is looking forward to repeating this conference and to cooperating further with the T&I Committee in other subject areas.

SME Accepts the Secretariat for the Surface Integrity Standard

As mentioned earlier, the previous comments barely scratch the surface of the quality picture. However, there are specific areas which SME's Quality Assurance Council has focused upon that can and do have an important bearing in Manufacturing and Quality Technology.

For many years, one of the QAC divisions has been working in the area of surface technology. It is a well known fact that many manufacturing processes simply generate new surfaces. For many critical parts and highly stressed components, manufactured surfaces must be produced with careful attention to surface integrity concerns in order to avoid premature part failure from fatigue or stress corrosion.

Before continuing further, it should be noted that surfaces are being and have been monitored largely by the measurement of surface roughness in accordance with the well known standard ANSI B46.1-1978, "Surface Texture." This standard, however, does not include the control of the many subsurface alterations which can occur as a result of metalworking processes such as machining and grinding. These alterations frequently override the effects of surface roughness and of other surface conditions covered by ANSI B46.1.

As one of its important activities, the Quality Assurance Council of SME has sponsored technical sessions at its annual meetings and has conducted seminars on the subject of Surface Integrity. Recently, SME took an important step in furthering the transfer of information on this subject by accepting the American National Standards Institute (ANSI) Secretariat for developing a national standard on Surface Integrity. This standard will serve as an instrument for defining testing procedures for evaluating surface integrity requirements.

The Role of Data in the Practical Application of Quality Technology

Setting up and maintaining an effective interrelationship of productivity, cost and quality in manufacturing is a difficult task at best--and almost impossible when definitive quality data are lacking. The following example, chosen because it provides background for SME's work on the ANSI Standard for Surface Integrity, is one of many that could be cited.

Grinding is a very widely used finishing operation for many components manufactured for use in DoD systems. All too often pressures to meet delivery create abusive grinding conditions such as those shown in an extreme case in Figure 1.

In many instances, however, the subsurface damage is so subtle that no known nondestructive final inspection method can detect the deliterious conditions which are produced. Under these conditions, component quality is totally dependent upon the control of processing parameters, the selection of which must be based upon well directed test programs. Experience gained from programs funded by the Manufacturing Technology Division of the AFML have led to the development of low stress grinding (gentle grinding) techniques which actually preserve the integrity of ground surfaces for critical and highly stressed components.

Figure 2 shows the endurance limit in reverse bending for a series of typically sensitive materials, namely, high strength steels, high temperature alloys, and titanium alloys. Each alloy was ground using low stress, conventional, and abusive conditions.

The data in Figure 2 make it very clear that under no circumstances should conventional grinding be employed for the manufacture of critical surfaces in these materials where component fatigue is an important functional consideration. Flatly--conventional grinding for alloys of the types shown in Figure 2 may in fact be catagorized as abusive.

The solution obviously is to use low stress grinding for those surfaces of sensitive alloys used for critical applications. However, it must be recognized that the application of low stress grinding can significantly impact productivity and cost. If sufficient data for a given sensitive alloy are not developed, the rates of metal removal must be very conservative, as shown in Table 1.

It has been shown, however, that when certain grinding parameters such as wheel speed, dressing procedures, and grinding wheel specifications are changed, then the rate of metal removal can be increased to tolerable levels. Table 2 shows conditions which caused cracking in cast turbine blades in comparison with those that did not. Cracking actually occurred in production at three plants and reached a 90% scrap level at one of them. In order to avoid cracking it is important to note that the

infeed per pass (the most important parameter influencing productivity) was only dropped from 0.004 inch to 0.002 inch and not to the 0.0002-0.0005 inch level normally used for specifying low stress grinding when insufficient data are available.

Productivity was not reduced to intolerable levels in the example cited above simply because the allowable increse in feed rates was available for the specific alloy based on experimentation and manufacturing experience. It is highly recommended that DoD through coordinating efforts of MTAG committees increase the emphasis on development of the type of data which can bring a common understanding among quality and production personnel. Unless adequate data are on hand, the newly developed and sophisticated process control and testing hardware may be overapplied, thereby needlessly decreasing productivity.

Further, it is important to note that random data are not sufficient for the establishment of inspection values. To establish respected limits, systematic data collections are required in order to relate the several operating parameters controlling a process to the effects being measured and to the significant material properties that affect component reliability. With the aid of mathematical modeling this need not be an endless process. The surface integrity ANSI standard sponsored by SME proposes development of a standard data set for each material and process combination of current interest. An example from among the several sets now in use is shown in Figure 3.

In conclusion, SME continues to demonstrate by its activities and its interest that it is aware of new opportunities for Quality Technology in the manufacturing industries. SME is organized to transfer information to the manufacturing sector and, therefore, is well prepared to cooperate with MTAG and other DoD groups in meeting quality objectives in manufacturing.

TABLE 1. PROCESS PARAMETER GUIDELINES FOR LOW STRESS GRINDING RESULTS

PROCESS PARAMETERS	GUIDELINES
1 Grinding wheel dressing technique	Frequent and coarse to maintain sharpness Maintain sharpness of dressing tool Avoid dwell in using crush, roll, or single-point dressing tools
2 Wheel speed	Low, under 3,500 fpm [18 m s]
3 Downfeed (or infeed) rate	0 0002 to 0 0005 inch/pass [0 005 to 0.013 mm/pass] with programmed reduction from conventional rates
4 Grinding fluid	Oil-base fluid is preferred
5 Wheel classification	Soft grade (G, H or I*) Open structure (6 or more). Grain size (60 or coarser)
6. Table (workpiece) speed	High, 50 fpm [15 m/min] and up. Crossfeed is preferred to plunge motion.
7 Grinding fluid flow control	Adequate to high fluid flow Assure placement of fluid between wheel and workpiece. Flow controlling nozzle design. Reduce air film on wheel

Source: G. Bellows, Low Stress Grinding: For Quality Production, MDC 78-103, Cincinnati, OH: Metcut Research Associates Inc., 1978, p. 29.

NOTE. Process parameter guidelines are listed in descending order of significance to low residual stress generation in the workpiece surface A machine and setup with good rigidity, freedom from vibration or chatter and well maintained with fine cleanliness are also an aid to grinding performance

*Cylindrical grinding frequently requires use of harder wheels (with J grade prevalent), however the other parameters must be selected to compensate for this extra hardness

TABLE 2. GRINDING PARAMETERS FOR IN-100 TURBINE BLADES
(Case A resulted in cracks; Case B resulted in no cracks)

GRINDING PARAMETERS	CASE A (Cracks)	CASE B (No Cracks)
Wheel	38A10018VBE	38A8018VBE
Wheel speed	5,500 fpm	2,800 fpm
Table speed	20 fpm	20 fpm
Infeed per pass	0.004 inch	0.002 inch
Fluid	Sulfo-chlorinated oil	Highly sulfurized oil
Grinding cycle	Rough: 0.060 inch at 0.004 inch/pass, dress. Leave 0.100 inch/side for finish operation. Finish: 0.012 inch from finish size (3 passes at 0.004 inch/pass; 2 sparkout passes).	Dress, feed 0.060 inch at 0.002 inch/pass; Dress, feed 0.060 inch at 0.002 inch/pass; Dress, feed 0.010 inch at 0.002 inch/pass to finish size

Source: Machining Data Handbook, Third Edition, Cincinnati, OH: Metcut Research Associates Inc., 1980, p. 18-89.

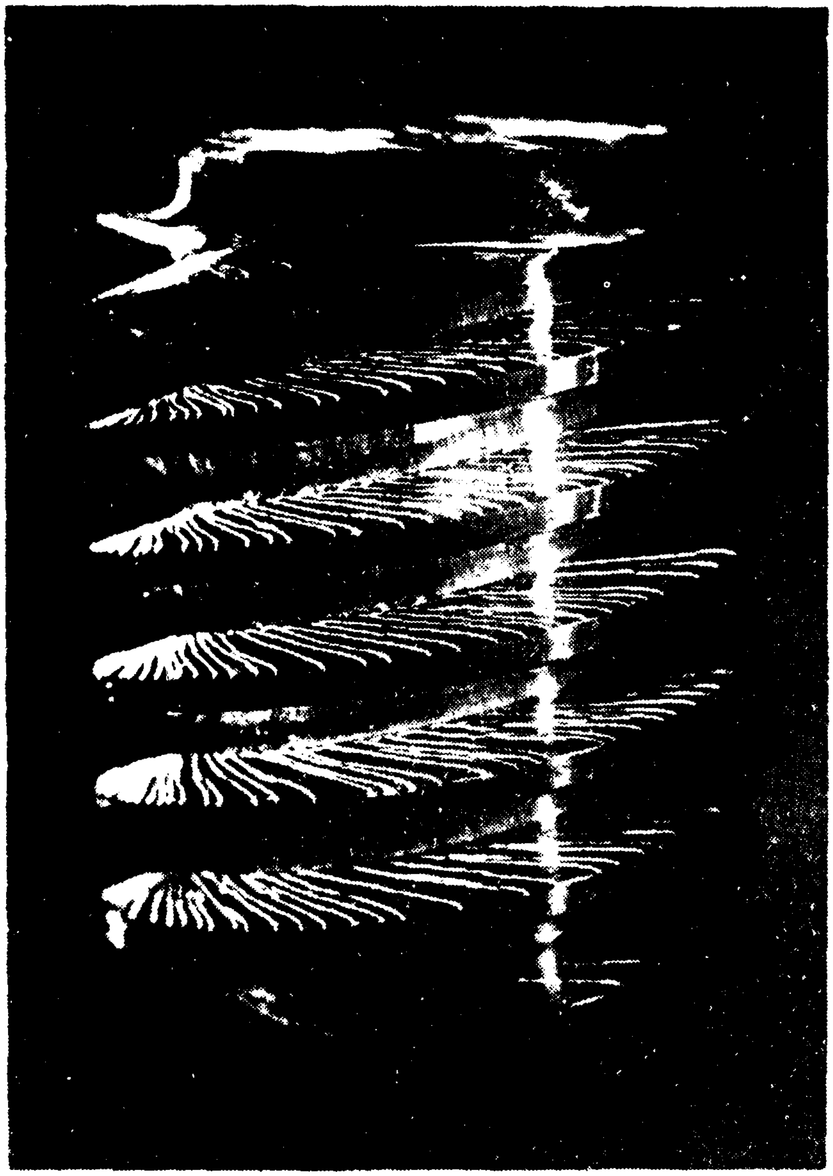


Figure 1. Failure in grinding of a carburized 8620 steel worm gear; an absence of surface integrity from leading edge dullness on plunge gear grinding. Ultraviolet light photograph of fluorescent penetrant indications found during inspection after grinding. (G. Bellows, Low Stress Grinding: For Quality Production. MDC 78-103, Cincinnati, OH: Metcut Research Associates Inc., 1978, p. 2)

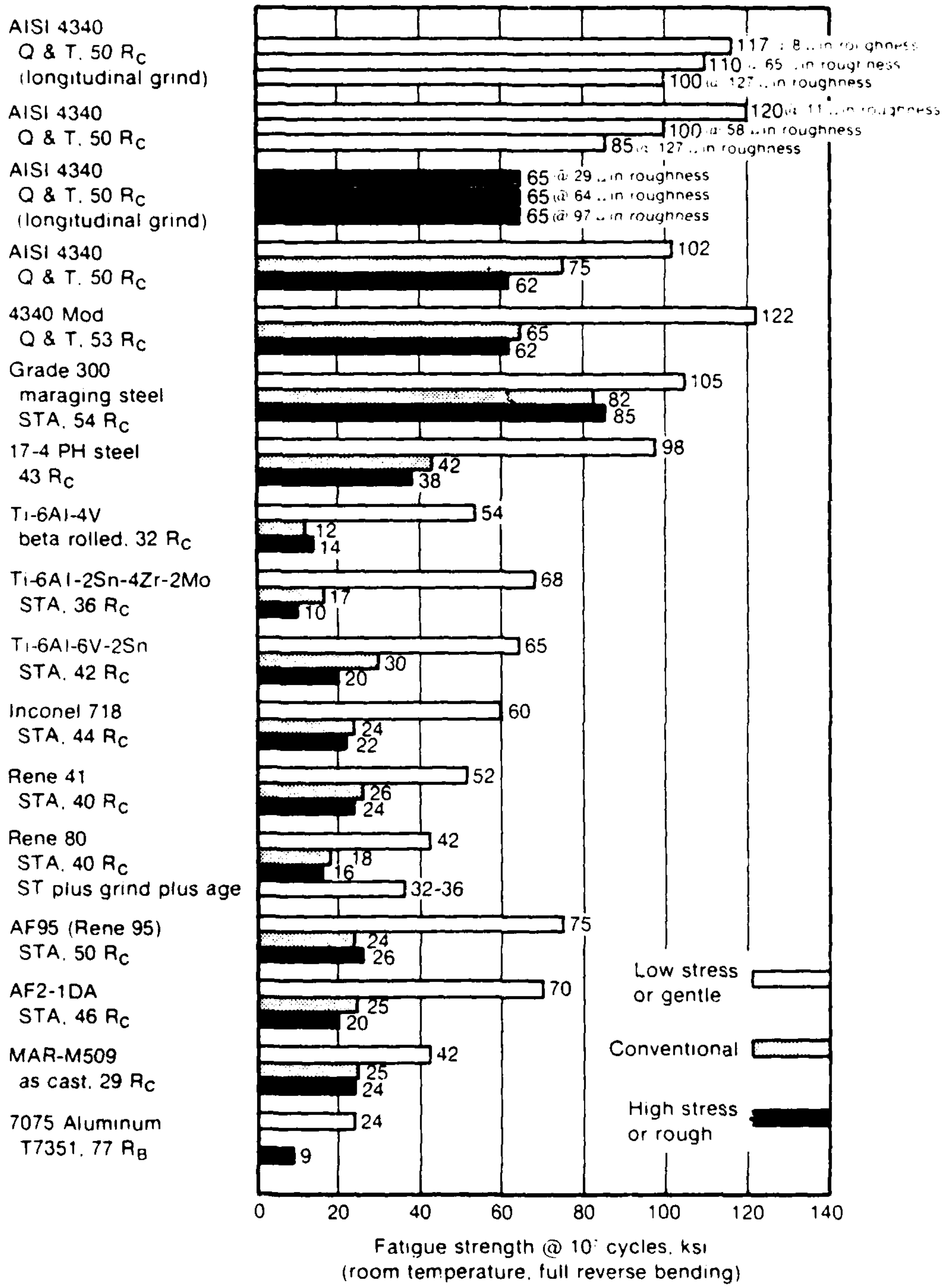


Figure 2. Summary of high cycle fatigue strength--surface traverse grinding. (Machining Data Handbook, Third Edition, Cincinnati, OH: Metcut Research Associates Inc., 1980, p. 18-84)

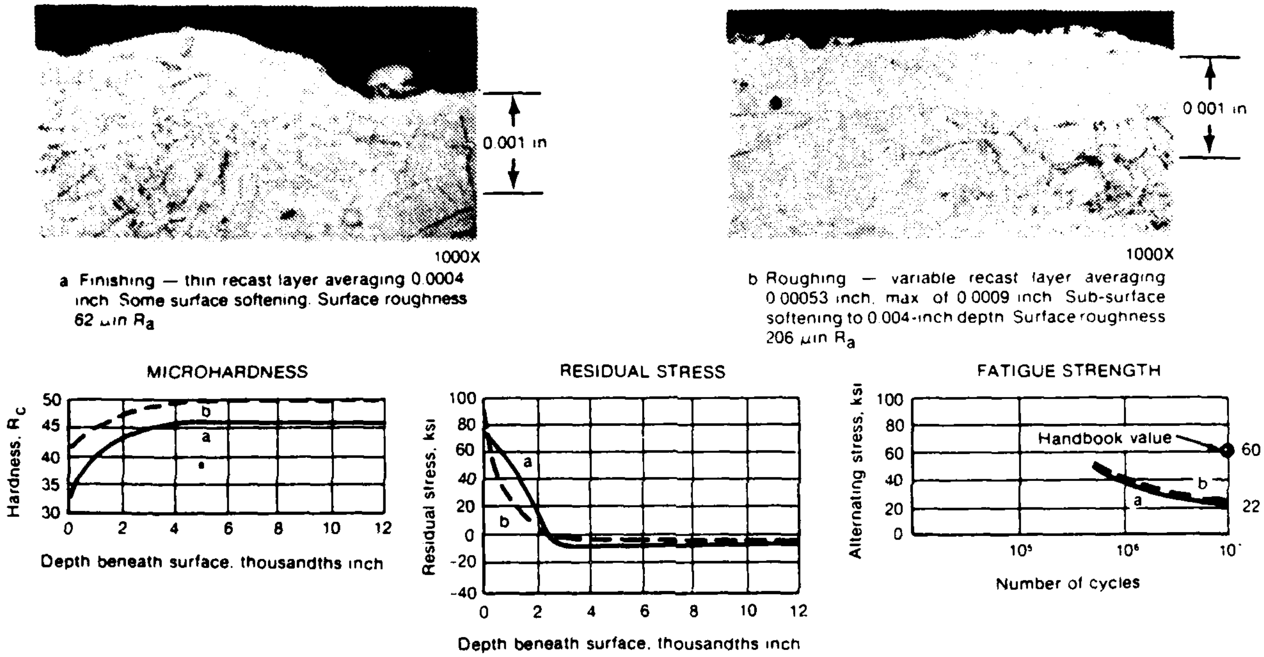
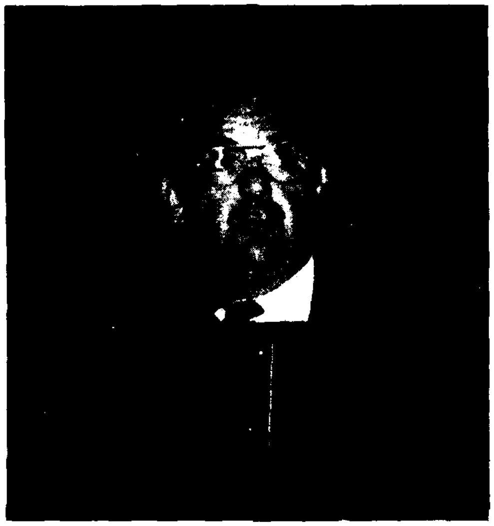


Figure 3. Surface integrity standard data set of EDM of Inconel 718 (solution treated and aged). Note that thin layers of recast (or the HAZ) can be as detrimental to fatigue strength as layers many times as thick. In this alloy, the reduction is 63% from the "handbook" high cycle fatigue strength of 60 ksi. (Machining Data Handbook, Third Edition, Cincinnati, OH: Metcut Research Associates Inc., 1980, p. 18-107)



EXECUTIVE FORUM

Moderator - MR. JOHN D. BLANCHARD

Principal Assistant Deputy for Materiel Development
U.S. Army Materiel Development and Readiness Command

PRECEDING PAGE BLANK-NOT FILMED

The first MTAG Executive Forum, at MTAG 78, explored how DoD and industry could improve manufacturing productivity and improve the responsiveness and competitive position of the U.S. industrial base. Last year's forum had similar goals. As a natural follow-on, this year's forum concentrated on how the DoD MT program could be used more effectively to increase productivity and lower weapon system costs; whether, indeed, the program is effective and how its results and implementation benefits could be quantified more effectively.

The consensus among panel members and observers was probably best summed up by John Deam, National Machine Tool Builders Association (NMTBA), who said that the taxpayers are getting their money's worth from the MT program and continuing DoD support is warranted. As noted by Dr. Goldhar, National Research Council (NRC), "If MT projects were short term and guaranteed a high return on investment, industry could do the job without help from the DoD MT program."

Messrs Dale Hartman, Electronic Industries Association (EIA), Marty Rogers and Joseph Anderson, USAF, and Captain Fred Hollick, US Navy, agreed that generic programs are hard to implement on the floor and tough to track.

However, Ralph Patsfall, Aerospace Industries Association (AIA), cautioned that small non-generic projects, while sometimes highly profitable, may be difficult to transfer; and that large, directed programs geared to the factory floor, such as a Sheet Metal Wedge or the Integrated Blade Inspection System, are more assured of implementation, including subcontractor participation.

Dale Hartman, EIA, William Gephardt, Cast Metals Federation, and Greg Barthold, Alcoa, all noted that greater MT emphasis should be devoted to electronics and to casting, forging and extrusion because of their broad impact and significant problem areas.

Eugene Davidson, Office of the Assistant Secretary of the Army (OASA), commented, "We have oversold cost reduction aspects of MT whereas readiness is our ultimate goal and we need to look more at scarce, critical materials. ROI is only one benefit." This view found considerable support at the forum and indeed represented the consensus and underlying theme for agreement.

As to tracking the Manufacturing Technology Program (MTP) results, the universal consensus was that it is too costly and too difficult and that the DoD and congress will have to go along with industrial procedures in terms of conducting and implementing MTP results. Industry cannot bother with inconsequential programs and the current MT program screening process assures that only those projects most likely to improve productivity, solve a particular production problem, have a high ROI and/or probability of success, will be funded.

While success cannot be guaranteed, industry acknowledges that it is in its best interest, as well as the Government sponsor's, to implement the results of an MT project which will privide improved readiness, fiscal or energy savings, reduced pollution or safety hazards. Not all of these factors represent measurable dollar savings, but all are clearly identifiable. Thus, the consensus of the MTAG 80 Executive Forum could clearly be said to have been that the DoD MT program is an effective tool to increase productivity, to improve our readiness posture, and to lower weapon costs; and that industry will continue to be a vital part of it.

BANQUET SPEAKER

by

MR. PETER F. McCLOSKEY

President, Electronic Industries Association

It is indeed a pleasure for me to be here with you this evening. It is also a pleasure to be out in "Reality" again. Perhaps I better explain -- as many of you know, EIA's headquarters is in Washington, D.C., which has recently been defined at 100 square miles completely surrounded by reality. And it is those realities that I would like to discuss with you this evening -- in particular Inflation, International Competitiveness and Decreasing Productivity Growth

While it is clear that a significant portion of our inflation has related to the oil shock, it is also apparent that our two chief competitor nations -- virtually completely dependent upon imported oil -- have withstood the ravage of inflation much better than we. They have resolved to pay the oil bill by increasing exports and to a large measure are succeeding -- and are succeeding at our expense.

We have been too complacent. For too long we have felt, or at least acted as if, we have been preordained to dominate the world marketplace -- lulled into that complacency perhaps by virtue of the fact that our industrial plant was intact at the conclusion of WW II -- lulled perhaps by the great record of production during that war when America was united on a goal to supply the forces of democracy with the means to assure victory. But we paid a price -- a price that we are still paying -- and we have been slow in waking to that reality. Our Marshall Plan brought the vanquished foe quickly along. They completely replaced their destroyed manufacturing capacity. We did not. In addition, we still seem to be operating under export policy presumptions that may have been true twenty years ago but are certainly not today. To quote Tom Murrin, President of Westinghouse Public Systems Company, our policies "seem to assume that the U.S. has a monopoly position in world trade and that we have the right to impose our morals on the rest of the world. Both of these assumptions are flawed. Instead of being a beacon of morality guiding the saved from a corrupt world, we are instead engaged in self-flagellation that much of the world views with amusement."

How have West Germany and Japan achieved their economic miracle? I think the facts demonstrate that they have focused their efforts better. Over the last twenty years, as our research and development in the United States has declined from 3 to 2.2% of our GNP, West Germany's and Japan's have increased dramatically to where there is a rough equivalence today -- West Germany's R&D is now 2.2% of their GNP and Japan's is 1.9% and, incidentally, virtually all in the commercial sector.

This has happened despite the growing awareness that the major capital stock of an industrial advanced nation is not its physical equipment; it is this body of knowledge amassed from tested findings of empirical science and the capacity and training of its population to use the knowledge effectively. Our treasure trove is our ability to innovate. That was true yesterday and will be more important tomorrow if we are to be in the competitive ballgame at all -- because of the increasing rapidity with which the world's new knowledge and technological innovations rapidly diffuse from high-wage economies to low-wage economies. It is a fact that we must run faster and faster to merely stand still. And increasingly we are beginning to realize this. This year, U.S. R&D will run approximately 60 billion dollars with about half of that federally financed and half financed by the industrial sector. The trend over the last twenty years has been for the industrial sector to finance an increasing percentage of the total R&D as the federal government reduces its percentage share. Unfortunately, an increasing amount of this industrial research is focused on shorter term research driven by industry's need for more immediate return on investment.

The figures show that over the past fifteen years, despite industry's increasing commitment, research and development has not kept pace with the growth of the economy--nor with that of our competitor nations. One measure of its consequences is the U.S. Patent Office report that foreigners now receive 37% of all U.S. patents, compared with only 20% twenty years ago.

What can be done about this? There are several things. Certainly an investment tax credit for privately financed research and development would help. EIA has supported such legislation because we feel that it would be the most efficient way of stimulating R&D at the corporate level, and would have the major benefit of industry having to put up its own money to qualify. This tax credit would be based on the increase in R&D by a corporation over the preceding year so that it could be truly targeted on increasing total R&D. Certainly the Cooperative Technology Centers proposed by the Commerce Department are a possibility, but their proposed funding level is small and the anti-trust implications may be difficult to overcome.

Perhaps it is time to focus on our anti-trust policy and see whether we can creatively fine-tune it so that joint industry research can be stimulated without deterring the benefits we get from truly competitive ventures. The Japanese have no such anti-trust constraints. In fact, in focusing on the semiconductor industry as one of their targeted industries, they directed the various companies form three joint ventures for the conduct of their federally financed R&D, free from the inhibition of anti-trust.

The results have indeed been significant. They have leaped forward to close the gap in our technological leadership in electronics. With 30 billion dollars of industry-financed research in the U.S., there is no doubt in my mind that the potential for leverage from joint research exists. Unlike a tax credit for R&D which would in effect be a tax expenditure, such joint R&D, properly implemented, could be a net addition to the total R&D being performed with no tax loss of revenues. While our anti-trust laws today theoretically would permit such ventures, the facts are that the mechanism

available through a business review letter by the Justice Department has been rarely used for joint research and development becau... industry is frankly skeptical that the anti-trust spectre will come back to haunt them. Understand that if the Justice Department signifies it does not presently challenge the proposed plan, that it can do so later and retroactively. According to the Justice Department, since 1972 through early 1980, they had reviewed ten joint ventures involving R&D and had cleared eight. That amounts to one R&D joint venture per year over the eight year period. We must find a way of balancing the needs of society for competitive research with its needs for focused and leveraged research. I believe it can be done through carefully constructed legislation that grants innovation for working the plan that justice approves. I do not believe this would be a panacea since I feel industry, brought up in the tradition of secrecy and proprietary data, would be slow to share its imagined competitive edge, but I suggest it may be imperative if we are to succeed in enhancing R&D and meeting the competitive challenges.

To that end, EIA met last week with a grouup of key policy advisers in the Federal Trade Commission to explore some initial thinking that may soon be reflected in draft legislation. I hope that we can move forward in this area. The payoff could be substantial.

Now I would like to focus on the theme of your Twelth Annual Conference -- Productivity Growth in the '80's. More than anything else, our record over the next decade in this vital area will determine whether we will be able to pass on to our children the enhanced quality of life and the standard of living that should be our destiny. I believe we have cause for optimism. First of all, in terms of absolute productivity, we still lead the world -- including West Germany and Japan. But increasingly we feel frustrated. We realize our rate of productivity growth has trailed the industrialized nations all through the '70's. And what is worse - on an absolute basis it turned negative in 1979 and will remain so in 1980. Certainly a portion of that poor showing relates to the business cycle, but not all of it can be so explained. Part of it relates to the marked decrease in the level of capital formation in our economy plus the growth of federal regulation and, to a lesser degree, changes in output mix represented by the shift in composition of our GNP from manufacturing toward services. Today's issue of the Wall Street Journal carried the second of a three part series listing 10 leading suspects for the decline.

Certainly part of it is attributable to a counterculture essentially opposed to industrialized society. An part too to the redirection of more of our nation's resources to "Quality of Life" and social economic justice as we struggle to find the proper balance between correcting the ills of society and refurbishing our industrial base. At the same time we are becoming more aware of the practical limits on our society. The basis for our optimism must be this new awareness -- the consensus which seems to be slowly emerging that we must evolve our unique approach to enhancing innovation, thereby improving productivity.

The causal connection between innovation and productivity is increasingly being taken for granted by an increasing number of Americans, has been the subject of cover stories in all the leading periodicals, and is part of the campaign rhetoric of the presidential candidates -- and indeed of politicians in general. That is an essential part of building a consensus, for congress will not take the requisite action without it.

Certainly a major factor in our solution must be increased capital formation. Few of the successes that you are experiencing in the Manufacturing Technology Program could have been possible without the availability of development funds. Fewer still can be implemented without capital expenditure. Return on investment must still be the name of the game. Faster depreciation of capital assets is essential if we are going to generate the cash required to take advantage of many of the opportunities for productivity improvement. I recently testified before the House Ways and Means Committee and gave EIA's productivity tax prescription. Besides the tax credit for R&D, it included support for 10-5-3, a form of accelerated depreciation more in line with the realities of capital investment and inflation plus the ' ting of tax penalties for Americans working overseas attempting to stimulate export sales.

These tax proposals are not a raid on the Treasury, two years ago, the Steiger Amendment was passed despite administration opposition. It was done to stimulate investment by reducing capital gain taxes. Has it worked? You bet it has.

Investment in venture capital firms, the financing of young and hopefully innovative business, climbed to $1 billion dollars in 1979 from the $300 million dollar average for the years 1974 through 1977 and is expected to hit $1.5 billion this year.

And what about Treasury's capital gain tax receipts. Then Secretary Blumenthal testified that the plan would cost the Treasury $2.2 billion annually. Instead of falling by the predicted $2.2 billion, capital gains receipts are rising to the tune of some $900 million a year.

General Guthrie in his opening remarks alluded to the historical adversarial role of government and industry. Certainly that must be changed, but I think that this MTAG activity is a major step in that direction. I can't help but feel, as I look around this room, that we are well on our way to closer industry/government relations because of cooperative MANTECH programs of DoD and the military services. The nations enjoying the best record of productivity improvement operate in an environment

of cooperation between government, industry, labor and academia. Properly channeled, these elements of society can create a powerful synergism aimed at achieving a common goal.

Let me suggest that the program all of you are involved in can be a powerful engine of change and a catalyst to spur the productivity growth, not only in defense but in manufacturing in general, that will spur us forward once again. The trends are clear. Unless we reverse them sometime early in this decade, on an absolute productivity basis we will be surpassed by Japan, West Germany, France and Canada. Through the next five years, DoD plans to spend well in excess of one billion dollars geared to improvement in productivity in manufacturing. No other nation on earth will be doing that. To the extent we implement those improvements, transfer the technology to our commercial sector and dedicate ourselves to maintaining our position as the most productive nation on earth, will likely determine the course of history. The challenge is no less than that. I am confident that we can do it. I am certain that we must.

INVITED GUEST SPEAKER

DR. ARDEN L. BEMENT

Deputy Under Secretary of Defense for Research and Engineering
(Research and Advanced Technology)

Good afternoon ladies and gentlemen.

It is indeed a pleasure for me to be here today and to interject a few of mmy own thoughts into this 12th Annual MTAG conference.

What I intend to do in the next few minutes is to first review my perceptions about why we have the Manufacturing Technology Program. Then to discuss some details about the Program and specific plans we have for it.

The United States is a strong nation and a world leader in many ways. Unfortunately, we are becoming incr .singly interdependent on the world community for our raw and finished materials. Furthermore, we are living in an era of unprecedented world change - to include political, economic, technological and military change.

For example, during the decade of the 1970's we lost ground to the Soviets in force modernization. For years we acknowledged that the Soviet Union held a quantitative lead in military equipment. But we believed our qualitative lead would more than compensate for this. But we have had to reexamine that belief and to reject the complacency that went with it. During the decade of the 1970's the Soviet Union made a major advance in the development and production of defense materiel. And as a consequence they have entered the 1980's in a dramatically different military posture than they had in the previous ten years.

Simply stated, their objective has been to challenge the U.S. lead in defense technology while maintaining their numerical advantage. They have had a remarkable degree of success in achieving that objective by making an enormous investment and by maintaining an unwavering emphasis on technology. The Soviet Union started the 1970's with an annual defense investment approximately equal to that of the U.S. But they have increased it at a steady rate of four percent per year since then, while the U.S. investment decreased in real terms every year until 1975. As a result, over the decade, the Soviet Union invested about $240 billion more than the U.S.

Generally speaking, they have used this incremental investment to produce large quantities of equipment, thus maintaining their numerical advantage. But they have also used their increased investment to fund R&D. Overall during the 1970's, the Soviet's invested about $70 billion more than we did in defense R&D. In addition, it is quite clear their R&D program has had the highest priority access to funds, to trained personnel and to scarce materials.

In sum, we see the Soviets entering the 1980's with a commitment to compete with U.S. weapon systems in quality and to no longer rely solely upon numerical superiority. A major start has already been made in that direction, and we see with it, the acceptance of higher unit costs implied by this commitment. For example, it is estimated that the cost of their MIG-23 approaches that of our F-16. They are accepting this increased unit cost without decreasing their traditional emphasis on quantity, simply by increasing their total investment.

The challenge to us is formidable but not insurmountable. We are behind quantitatively in deployed equipment and are falling further behind because of disparities in equipment production rates. But we also have some distinct advantages: a superior technological base, a competitive industry with high productivity and allies with a substantial industrial capability. Our overriding near term need is to get on with the modernization of our forces. However, our superior technology, our highly productive industrial base, and our allies' industrial capacity do not provide our armed forces leverage until they result in fielded and operational materiel. Thus, one of the first and foremost components of our investment strategy must be to revitilize our industrial base so that it can produce defense materiel in an orderly and efficient manner within the resources available to us.

That is where the Manufacturing Technology Program comes in. While it is a relatively small portion of our industrial base investments, it is a very important portion for it pushes the state-of-the-art. Its basic purpose is to provide advanced manufacturing technology permitting more productive use of other resources. Over the years ahead we expect MANTECH investments to enable us to provide greater numbers of weapons systems of higher quality than if the investments had not been made.

Let met illustrate how MANTECH investments can provide long term payback by citing three examples from over thirty presented to me several months ago by the three military departments. The first deals with the production of ammunition. The Army increased the output per shift by 308% by automating the loading of detonators. This new loading process has not only reduced the need for one complete loading facility, providing a $37 million cost avoidance but has also significantly reduced the number of personnel exposed to a hazardous environment. As a second example, the Air Force has recently completed a new computerized, ultrasonic turbine disk inspection system which has reduced disk inspection time by 50% while simultaneously improving the reliability of the inspection process. This new method permits the use of near net shape forgings thus providing additional savings in high cost, scarce materials and machining costs. A third automated process has reduced center core igniter loading and assembling costs by $6 per unit and has resulted in a reduction of 61 personnel per production line. With benefits like these, one cannot help but be enthusiastic about the MANTECH Program.

I would now like to address some specific plans and initiatives for the future.

First, what about the funding situation? During the period from FY 1972 thru FY 1976, the total investment for all three Military Departments was $350 million - roughly $70 million per year. During the most recent five years, FY 1977 thru FY 1981, our MANTECH budget was $630 million - roughly $125 million per year. At this time, we believe we have solid justification for the next five years of $1.3 billion - roughly $250 million per year. This profile can be summarized quite nicely. In the last five years, we doubled the budget over the previous five years, and we plan to double it again in the next five years. Thus in terms of fiscal support, there can be no doubt of DoD's top management support for this program. As these levels of funding materialize, we can expect to receive added program visibility. MANTECH budgets will no longer be below the noise level. Thus we must place particular emphasis on refining and strengthening the management of the program to be assured that we can adequately respond to the scrutiny that larger budgets attract.

My initial approach in strengthening the Program early this year was to form a task force to take a hard look at the more global aspects of MANTECH program management. The most visible task force output is the Statement of Principles you are now all familiar with. Our intent in establishing this document was to put down on paper the basic program foundation on which we could base any needed refinement of policies and procedures. These Principles have received the endorsement of the Deputy Secretary of Defense who asked the Secretaries of the Military Departments to brief the Under Secretary for Research and Engineering on what they are doing to adopt the principles.

These briefings took place about three weeks ago and were extremely well received. Highlights include: the Army indicated a very high level of program success and intends to double their budget over the next several years; the Navy has made some organizational realignments and will fence the MT budget during the next several years to assure that they do not experience the budget oscillations seen in past years; the Air Force intends to undertake a series of Tech Mod projects designed to modernize several weapons systems production facilities. They will also undertake a series of efforts to improve their repair and overhaul capabilities. In summary, Dr. Perry was extremely pleased with these initiatives and offered his support. Those of you who participated in the preparation of these briefings are to be complimented for your efforts.

During the coming year, I will place a great deal of emphasis on identifying where project results are being implemented and on documenting what benefits are being achieved. I consider collecting this information essential to achieving the credibility necessary to meet our long term goals. Each Military Department has already been tasked to establish appropriate procedures and has recently briefed the MTAG Executive Committee on their progress. Quite frankly, I was hopeful for greater progress than was reflected in these briefings. However, it is apparent that DoD MT community cannot succeed in this initiative without industry's help. The difficulty lies in identifying when and where that information, the major output of a MANTECH project, is used and what benefits are achieved. I recognize that the private sector is under no obligation to tell us when you have used project results but I encourage you to do so. If necessary we can treat the details as proprietory information and can shield your identity in any of our published summaries. I'm convinced we have much more implementation and program payback than we are able to identify unilaterally and we need industry's cooperation with this initiative.

Another of our ongoing activities is the establishment of a DoD MANTECH data base which is intended to serve two primary purposes - it will permit us to better manage MANTECH Program resources and will also permit us to transfer and diffuse the technical information more rapidly and effectively throughout the industrial base. This system will be implemented at the Defense Technical Information Center - formerly the Defense Documentation Center. As the system matures, we will make key information about each project available to all companies who have access to remote terminals. This project has gone slower than I would like but I intend to place greater emphasis on implementing it in the coming year.

A third initiative just getting under way is the revision of the DoD Instruction on MANTECH Program policy. There are a number of basic issues which must be addressed during this process. Perhaps the most important concerns the definition of a MANTECH project. Some of the questions that must be addressed include: Which projects should be RDT&E funded and which Procurement funded? Should a MANTECH project support only one weapons system and if so, under what conditions? Should we fund projects having a secondary impact such as the preparation of a handbook about manufacturing processes or materials parameters? What projects are appropriate early in the development cycle of an item as compared with manufacturing technology needed at the later stage of mass production? Clearly the MANTECH Program has a role in these situations. But we must assure those who may view us critically that we have a well thought out program, consistent with other DoD and national policies.

Now I would like to address technical initiatives.

One of the responses to the briefings to Dr. Perry was his enthusiastic endorsement of the Navy's plan to establish an aggressive, long term MANTECH program to reduce shipbuilding and ship overhaul costs. These opportunities are unique to the Navy and have the potential of providing a substantial economic payback to the DoD for one of the largest areas of DoD procurement. During the coming year, I intend

to encourage the Navy to pursue this initiative in detail and to assist them where I can. I encourage those of you who have a stake in this industry to help us establish a well thought out and meaningful program in this area.

There is yet another area in need of an infusion of improved manufacturing technology - our repair and rebuild facilities. As the cost of our weapons systems have gone up, the cost of maintaining them has also gone up. In addition, higher acquisition costs have forced us to keep some of our fielded systems in service for longer and longer periods of time. Yet we are tryping to maintain some of these sophisticated systems with something less than modern repair and rebuild technology. In other areas we are now producing weapons systems components for which we have minimal repair capability - for example composite structures repair. This situation cannot be allowed to continue. we have made some funding inroads in this area, but I firmly believe there are many additional opportunities that deserve to be pursued aggressively.

There is yet another initiative which I anticipate will materialize in the near future but which is gestating at this point. It deals with investments to improve our machine tool industry. Last week, I participated in the presentation of the final report of the Machine Tool Task Force to U.S. industry. This Air Force sponsored effort was intended to provide overall guidance to the nation concerning directions we should move to enhance the technology of this vital segment of our national economy and security. We have not yet had time to fully mine the results of this assessment but let me cite just one example where new frontiers are opening.

Many of you are familiar with high speed machining and have seen or heard about our investments in this area. Our initial implementation of this new technology occured in the TRIDENT program where a high speed milling machine is producing components to improve missile performance that could not be made economically any other way. Whereas in the past we have designed machine tools to be heavy and rugged to take large cutting tool forces, this design philosophy is now working against us. The cutting force loads of a high speed spindle are much less, and do not need the massive support structures whose inertia forces limit the speed at which we can control spindle movements on machine ways. New, lighter weight, machine tool structures may evolve to take full advantage of this new technology. Perhaps composite structurs will come into play. I anticipate that the MANTECH Program will play a role in some of the opportunities identified by the MTTF.

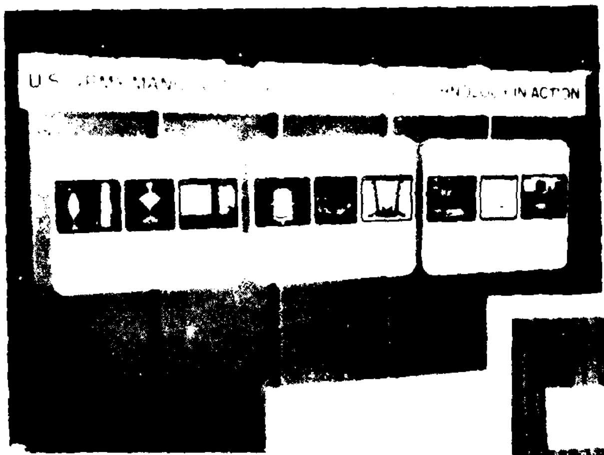
What else can we foresee for the MANTECH Program in the near future? I still intend to provide strong support for our efforts in Integrated Computer Aided Manufacturing, in near net shape forgings and castings, in advanced inspection and quality assurance technology and in a variety of productivity enhancement measures in the electronics areas just to name a few thrusts already underway. Our thrust to support the modernization and expansion of the ammunition production base will also continue for as I illustrated above, we have already had significant successes in that field and I am sure there will be more. We will continue our thrusts in a variety of composite manufacturing processes. But I also expect we will include other major areas not yet fully developed. For example, we have not had a significant long term effort to improve the productivity of tracked combat vehicle production with the notable exception of the XM1 tank facility at Lima, Ohio. With the M2 and M3 vehicles following shortly behind, I cannot help but believe there is an array of technologies that can provide a significant payback in combat vehicle manufacture for a relatively small MANTECH investment. The FY 82 budget request does show movement in this area.

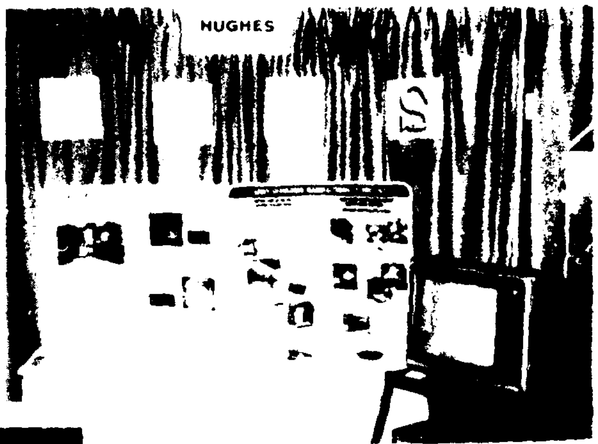
What I intend to work toward in the future is a "high quality" Manufacturing Technology Program. "Quality" is a term hard to define. Yet we all know it when we see it and when we do not. In my opinion, the Manufacturing Technology Program already has many attributes which could lead one to say it has "quality." Yet as I have outlined above, it has some rough edges which when removed, will improve our perception of its "quality."

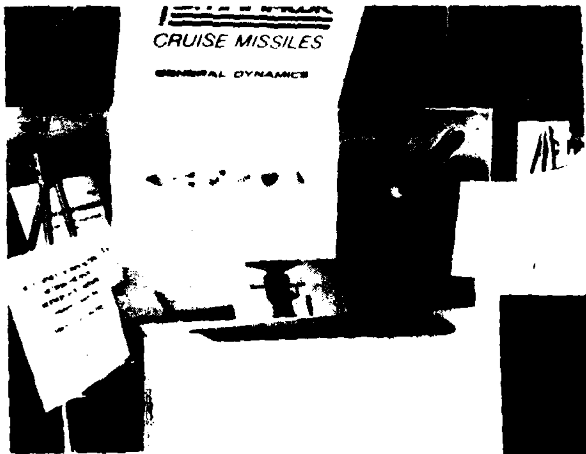
I started my remarks by discussing some of the formidable challenges placed before us by our potential adversaries. The Soviet Union leadership clearly recognizes that scientific and technical progress will have "decisive significance" in their competition with the Western World. But what counts in the final analysis is our own ability to translate our technology into a productive capacity capable of providing an effective military posture.

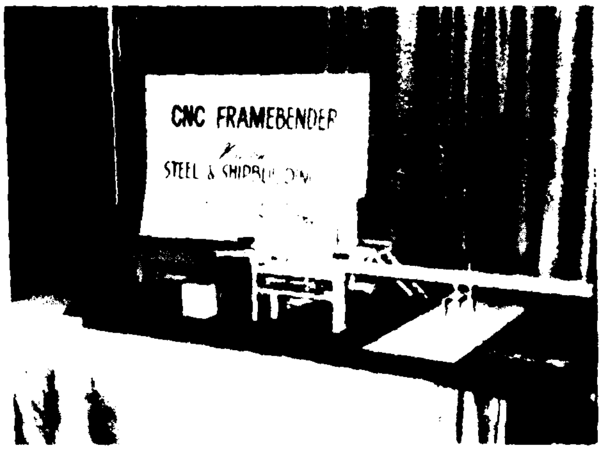
Each of us here today has a unique opportunity and an obligation to increase the strength and productivity of our industrial base and to significantly enhance our defense readiness posture. A major contribution in this endeavor will be a strong, viable, productive, Manufacturing Technology Program which adheres to sound business as well as sound technical policies.

EXHIBITS

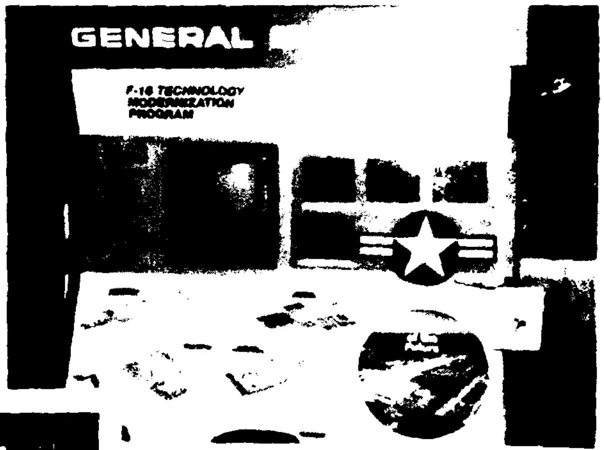

IN ACTION


HUGHES

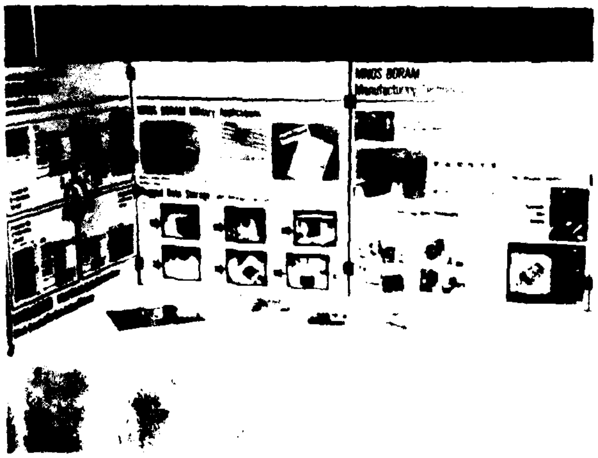

CRUISE MISSILES
GENERAL DYNAMICS

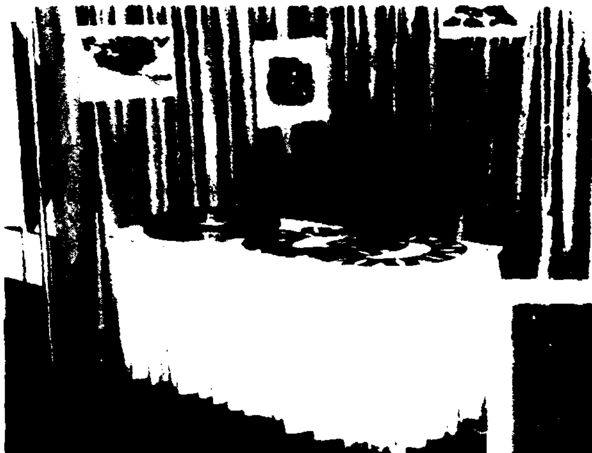

CNC FRAMEBENDER

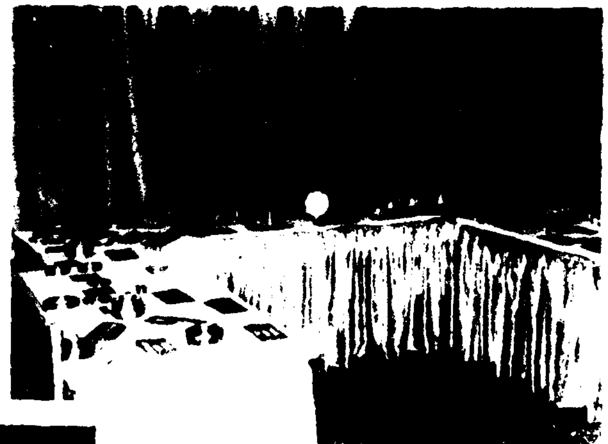

RCA
RCA

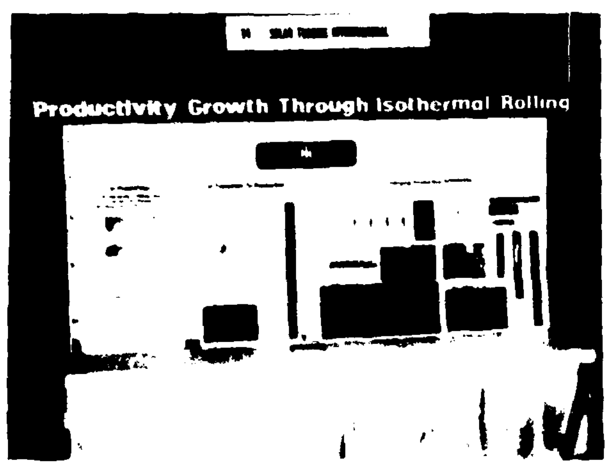

GENERAL
F-16 TECHNOLOGY
MODERNIZATION
PROGRAM


MATERIALS ENGINEERING
AND TECHNOLOGY


MNOS BORAM
Manufacturing






Productivity Growth Through Isothermal Rolling

CONFERENCE SCENES

LIST OF ATTENDEES

ABBOTT, T. J.
Chemical Systems Laboratory
ATTN: MR. T. J. ABBOTT
DRDAR-CLR-I
Aberdeen Proving Ground, MD 21010

ABRAMS, M. C.
General Dynamics-Pomona Div.
ATTN: MR. MARVIN C. ABRAMS
Manager, Advanced Mfg. Tech.
M/S 4-26
P.O. Box 2507
Pomona, CA 91766

ACUFF, R.
Tracor Aerospace
ATTN: MR. RICHARD ACUFF
Mail Stop 2-1
6500 Tracor Lane
Austin, TX 78721

ADAMS, A. A.
FMC Corporation
ATTN: MR. A. A. ADAMS
Liaison Manager
Eng. Systems Div.
8629 Andromeda Road
San Diego, CA 92126

ADELMAN, S.
US Army Armament R&D Command
ATTN: MR. S. ADELMAN
Chief, Expl. Sec. ESPD, LCWSL
DRDAR-LCM-E
Building 3305
Dover, New Jersey 07801

AGERTON, W. W.
Microelectronics Engineering Corp.
ATTN: MR. W. W. AGERTON
P.O. Box 1209
Auburn, AL 36830

ALBANI, CPT L. R.
HQ, Air Force Logistics Command
ATTN: CPT LOUIS R. ALBANI
ATTN: AFLC/PMMP
Wright-Patterson AFB, OH 45433

ALEX, R. P.
Ralph P. Alex & Associates, Inc.
ATTN: MR. RALPH P. ALEX
President
1037 Stratfield Road
Fairfield, CT 06432

ALLEN, M. M.
Pratt & Whitney Aircaft Group
ATTN: MR. MARVIN M. ALLEN
Sr Program Mgr., Gov. Contracts
M/S M-06, GPD-MMT
P.O. Box 2691
West Palm Beach, FL 33402

ALTIZER, J.
Lockheed-California Company
ATTN: MR. JOHN ALTIZER
Mfg. Res. Technical Sales Manager
Dept. 1122, Bldg. 152, B-1
P.O. Box 551
Burbank, CA 91520

AMBROSINI, L. R.
US Army Armament Matl Read Cmd
ATTN: MR. L. R. AMBROSINI
Deputy for Life Cycle Management
Rock Island Arsenal
Rock Island, IL 61299

AMICONE, R. G.
US Army Depot Support Command
ATTN: MR. R.G. AMICONE
ATTN: DRSTS-PE
Chambersburg, PA 17201

ANDERSON, F. E.
US Army Industrial Base Eng. Activity
ATTN: MR. FERREL E. ANDERSON
DRXIB-MT
Rock Island, IL 61299

ANDERSON, J. B.
HQ, Air Force Systems Command
ATTN: MR. JOSEPH B. ANDERSON
Director of Manufacturing
AFSC/PMD
Andrews AFB, MD 20334

APPLEMAN, H. C.
Innova
ATTN: MR. HOWARD C. APPLEMAN
Consultant
P.O. Box 3214
Santa Monica, CA 90403

ARMSTRONG, SUSAN R.
Battelle-Columbus Laboratories
ATTN: SUSAN R. ARMSTRONG
Manager, Conference Coordination
505 King Avenue
Columbus, OH 43201

ARONOWITZ, B.
US Army Armament R&D Command
ATTN: MR. BERNARD ARONOWITZ
ATTN: DRDAR-QAS-T
Building 62
Dover, NJ 07801

AUDINO, F. J.
Watervliet Arsenal
ATTN: MR. F. J. AUDINO
SARWV-QA
Watervliet, NY 12189

BACHMAN, H. L.
Hazeltine Corporation
ATTN: MR. HENRY L. BACHMAN
Vice President
Greenlawn, NY 11740

BAER, JOHN L.
HQ, US Army Matl Dev & Read Cmd
ATTN: MR. JOHN L. BAER
DRCMT
5001 Eisenhower Avenue
Alexandria, VA 22333

BAILEY, DR. J. A.
North Carolina State University
ATTN: DR. JOHN A. BAILEY
Professor
Dept. of Mech. & Aerospace Eng.
Raleigh, North Carolina 27650

BAKER, J. W.
Rockwell International
ATTN: MR. JOHN W. BAKER
Rocky Flats Plant
Energy Systems Group
P.O. Box 464
Golden, CO 80401

BAKER, SR., R. H.
Naval Air Rework Facility
ATTN: MR. ROBERT H. BAKER, SR.
CODE 642
Naval Air Station
Jacksonville, FL 32212

BARASH, M.
Purdue Univ
ATTN: MR. MOSHE BARASH
School of Indus Eng
Grissom Hall
West Lafayette, IN 47907

BARNETT, H. R.
Office of Dep. Ch. Staff for RDA
ATTN: MR. HARRELL R. BARNETT
Washington, D.C. 20310

BARTHOLD, G. B.
ALCOA
ATTN: MR. GREGORY B. BARTHOLD
Manager, Tech. Prog.
1200 Ring Building
Washington, DC 20036

BARTLETT, D. A.
A. T. Kearney, Inc.
ATTN: MR. DONALD A. BARTLETT
222 S. Riverside Plaza
Chicago, IL 60606

BARTOLOMEI, F. R.
Lockheed Missiles & Space Company
ATTN: MR. F. R. BARTOLOMEI
Manager, Manufacturing Operations
B/578, 0/56-41
P.O. Box 504
Sunnyvale, CA 94086

BARTON, S. L.
FMC Corporation
ATTN: MR. SUMNER L. BARTON
Assistant Division Manager
Eng. Systems Division
328 Brokaw Road
Santa Clara, CA 95052

BARTSCH, B. E.
Office of Under Sec of Defense (R&E, AP)
ATTN: MR. BURTON E. BARTSCH
Two Skyline Place, 14th Floor
5203 Leesburg Pike
Falls Church, VA 22041

BAUCOM, R. M.
NASA-Langley Research Center
ATTN: MR. ROBERT M. BAUCOM
Mail Stop 188A
Hampton, VA 23314

BAUER, G.
Honeywell Corporation
ATTN: MR. GEORGE BAUER
Project Staff Engineer
MS 350-1
13350 U.S. Highway 19, North
St. Petersburg, FL 33733

BAUMGARTNER, P.
Office of Asst Secretary of Navy (MRA&L)
ATTN: MR. PETER BAUMGARTNER
Room 250
Washington, DC 20360

BAX, B.
Naval Air Rework Facility
ATTN: MISS BRENDA BAX
Industrial Engineer, ATAP
CODE 640
Norfolk, VA 23511

BEDELL, R. J.
General Dynamics
ATTN: MR. ROBERT J. BEDELL
Supervisor, Mfg. Tech.
Mail Stop 6461
P.O. Box 748
Fort Worth, TX 76101

BELDEN, D. M.
RCA Corporation
ATTN: MR. DUANE M. BELDEN
Mail Stop 18-1
P.O. Box 588
Burlington, MA 01803

BELL, D.
Systems Research Lab
ATTN: MR. DAVID BELL
Mail Stop IR50
2800 Indian Ripple Road
Dayton, OH 45440

BELLIN, A. I.
General Electric Company
ATTN: MR. ALBERT I. BELLIN
Mgr., Adv. Prog. Mgmt.
M/S 374A8
1000 Western Avenue
Lynn, MA 01910

BELLO, M. T.
USAF, Aeronautical Systems Division
ATTN: MR. MICHAEL T. BELLO
ATTN: ASD/ENO
Wright-Patterson AFB, OH 45433

BELLOWS, G.
Metcut Research Associates, Inc.
ATTN: MR. GUY BELLOWS
Staff Engineer
3980 Rosslyn Drive
Cincinnati, OH 45209

BEMENT, JR., DR. A. L.
Dep. Under Sec. of Defense, R&AT
ATTN: DR. ARDEN L. BEMENT, JR.
Room 3E114
Pentagon
Washington, DC 20301

BERNIER, JOSEPH (BUD)
US Army Matls & Mech Res Ctr
ATTN: MR. JOSEPH A. BERNIER
DRXMR-PMT
Watertown, MA 02172

BILES, W. E.
Pennsylvania State University
ATTN: MR. WILLIAM E. BILES
Professor and Head
Dept. of Ind. & Mgmt. Sys. Eng.
207 Hammond Bldg.
University Park, PA 16802

BLACK, J. T.
Ohio State University
ATTN: MR. J. T. BLACK
1971 Neil Avenue
Columbus, OH 43210

BLOOMER, J.
Naval Ship Systems Eng. Station
ATTN: MR. JOSEPH BLOOMER
Code 035.1
Philadelphia, PA 19112

BLUE, J. L.
Defense Logistics Agency
ATTN: MR. JOSEPH L. BLUE
ATTN: DLA-SCT
Cameron Station
Alexandria, VA 22314

BOCK, R. G.
ITT Gilfillan
ATTN: MR. R. G. BOCK
Mail Stop 13
P.O. Box 7713
7821 Orion Avenue
Van Nuys, CA 91403

BOHM, M.
CPI Corporation
ATTN: MR. MILFORD BOHM
1706 Washington Avenue
St. Louis, MO 63141

BONINE, W. J.
McDonnell Aircraft Company
ATTN: MR. WILLIAM J. BONINE
Marketing Manager
P.O. Box 516
St. Louis, MO 63166

BOOMAN, R. A.
Naval Air Rework Facility
ATTN: MR. ROBERT A. BOOMAN
CODE 61100, Bldg. 604
Naval Air Station
Pensacola, Florida 32508

BOTROS, DR. B. M.
NC A&T State University
ATTN: DR. B. M. BOTROS
Professor, Mechanical Engineering
Greensboro, NC 27411

BOWLING, W. L.
Naval Air Rework Facility
ATTN: MR. W. L. BOWLING
CODE 64100
Mail Stop 9
Cherry Point, NC 28533

BOYD, MAJ G.
HQ, Air Force Systems Command
ATTN: MAJ GEORGE BOYD
Directorate of Mfg.
AFSC/PMD
Andrews Air Force Base, MD 20334

BRAUN, G. W.
General Dynamics
ATTN: MR. GEORGE W. BRAUN
Mail Zone 4-26
P.O. Box 2507
Pomona, CA 91766

BRAVOCO, R. R.
SofTech, Inc.
ATTN: MR. RALPH R. BRAVOCO
Vice President
CAD/CAM Division
460 Totten Pond Road
Waltham, MA 02154

BRAZYS, D. M.
FMC Corporation
ATTN: MR. DANIEL M. BRAZYS
Production Project Manager
Northern Ordnance Division
4800 E. River Road
Minneapolis, MN 55421

BREWER, J. E.
Westinghouse Electric Company
ATTN: MR. JOSEPH E. BREWER
MS-3525
P.O. Box 1521
Baltimore, MD 21203

BRIGGEMAN, E. R.
MRC Corporation
ATTN: MR. EUGENE R. BRIGGEMAN
Marketing Manager
11212 McCormick Road
Hunt Valley, MD 21031

BRIGGS, W. R.
Los Angeles Air Force Station
ATTN: MR. W. R. BRIGGS
Space Division, SD/PMDM
P.O. Box 92960
Worldway Postal Center
Los Angeles, CA 90009

BRIM, D. W.
US Army Industrial Base Eng. Activity
ATTN: MR. DELMAR W. BRIM
DRXIB-MT
Rock Island, IL 61299

BRISTOL, S. L.
Honeywell, Inc.
ATTN: MR. STUART L. BRISTOL
Mail Stop 11-2320
600 2nd Street, N.E.
Hopkins, MN 55343

BROWER, W. S.
Control Data Corporation
ATTN: MR. W. BROWER
124 Hebron Avenue
Glastonbury, CT 06033

BROWN, A. R.
McDonnell Douglas Astronautics Co.
ATTN: MR. ALAN R. BROWN
Dept. E457, Bldg. 270E/3/Room 334
M/S 024
P.O. Box 516
St. Louis, MO 63164

BROWN, F. W.
MRC Corporation
ATTN: MR. FREDERICK W. BROWN
Vice Pres., Operations
11212 McCormick Road
Hunt Valley, MD 21031

BROWN, G.
General Dynamics
ATTN: MR. GARY BROWN
Senior Project Engineer
Mail Stop 43-6310
5001 Kearny Villa Road

BRUCE, J. S.
Naval Air Systems Command
ATTN: MR. JOSEPH S. BRUCE
15 42nd Street, N.E.
Washington, DC 20019

BRYANT, J. B.
Charleston Naval Shipyard
ATTN: MR. JOHN B. BRYANT
CODE 382
Charleston, SC 29412

BRYNIARSKI, COL A. F.
Air Force Logistics Command
ATTN: COL ALBERT F. BRYNIARSKI
C-5 Wing MOD Program Manager
Wright-Patterson AFB, OH 45433

BUCKLEY, M. J.
Defense Adv. Res. Projects Agency
ATTN: MR. MICHAEL J. BUCKLEY
1400 Wilson Blvd.
Arlington, VA 22209

BUELL, G.
USAF Wright Aeronautical Labs
ATTN: MR. GLEN BUELL
ATTN: AFWAL/MLTE
Electronics Branch
Wright-Patterson AFB, OH 45433

BUFFUM, H. E.
Boeing Company
ATTN: MR. HARVEY E. BUFFUM
Director, Operations Technology
M/S 77-31, Dept. 6-3000
P.O. Box 3707
Seattle, WA 98124

BUKKILA, C. J.
Sperry Univac, Defense Systems Div.
ATTN: MR. CHARLES J. BUKKILA
Manager, Adv. Mfg. Techniques
MS U2P25
P.O. Box 3525
St. Paul, MN 55104

BUNTING, P. M.
General Dynamics/Ft. Worth Div.
ATTN: MR. PHILLIP M. BUNTING
Mfg. Tech. Superviso
M/S 6215
P.O. Box 748
Fort Worth, TX 76101

BURGESS, J. E.
Varian Associates
ATTN: MR. JAMES E. BURGESS
Palo Alto Microwave Tube Div.
Building 1, M/S A-047
611 Hansen Way
Palo Alto, CA 94303

BURGETT, C. T.
E-Systems, Mencor Division
ATTN: MR. CLIFFORD T. BURGETT
Manager, Manufacturing Systems
P.O. Box 23500
Tampa, FL 33623

BURMEISTER, W. A.
Nuclear Metals
ATTN: MR. WILLIAM A. BURMEISTER
Vice President, Marketing
2229 Main Street
Concord, MA 01742

BURTON, C. J.
Special Metals Corp.
ATTN: MS. CLAUDIA J. BURTON
New Products Analyst
Middle Settlement Road
New Hartford, NY 13413

BUSHELLE, W. R.
McDonnell Douglas Astronautics Co.
ATTN: MR. WILLIAM R. BUSHELLE
Dept. E080, Bldg. 270/E/3/PST,E14
Mail Stop 024
P.O. Box 516
St. Louis, MO 63166

BUSHEY, B. W.
US Army Armament R&D Command
ATTN: MR. B. W. BUSHEY
DRDAR-LCU-M
Building 65S
Dover, New Jersey 07801

BYRON, H. B.
Naval Sea Systems Command
ATTN: MR. HARRY B. BYRON
CM4 RM109
Washington, DC 30162

CAFFIAUX, J.
Electronic Industries Assoc.
ATTN: MR. JEAN CAFFIAUX
Vice President
2001 Eye Street, NW
Washington, DC 20006

CAPUTO, F.
Oregon Metallurgical
ATTN: MR. FRANK CAPUTO
Vice President
P.O. Box 580
Albany, OR 97321

CARL, E.
E-Systems, Memcor Division
ATTN: MR. ED CARL
Manager, Mfg. Eng.
P.O. Box Z
Highway 48
Bushnell, FL 33513

CARSTATER, D.
HQ, Naval Material Command
ATTN: MR. DAVID CARSTATER
Productivity Eng., Ind. Cap. & Tech.
MAT 00K9
Washington, DC 20360

CARSTENS, J.
US Army Industrial Base Eng. Activity
ATTN: MR. JAMES CARSTENS
Chief, Manufacturing Technology Div.
DRXIB-MT
Rock Island, IL 61299

CASSIDY, E.
US Army Mun. Prod. Base Mod. Agency
ATTN: MR. EDWARD CASSIDY
ATTN: SARPM-PBM-ME
Building 171
Dover, NJ 07801

CAULFIELD, R. J.
General Motors Corporation
ATTN: MR. ROBERT J. CAULFIELD
Manufacturing Development
General Motors Technical Center
Warren, MI 48090

CERNY, J.
E-Systems Inc., ECI Div.
ATTN: MR. JAMES CERNY
Director of Manufacturing
Mail Stop 13
1501 72nd Street, North
St. Petersburg, FL 33710

CHAISSON, B.
Hobart Brothers
ATTN: MR. BILL CHAISSON
Mgr, Special TIG & Plasma Welding Sys.
600 West Main Street
Troy, OH 45473

CHAN, G.
Varian Associates
ATTN: MR. GEORGE CHAN
Building 1, MS A-047
611 Hansen Way
Palo Alto, CA 94303

CHAN, W. W.
General Electric Company-TEMPO
ATTN: MR. WARREN W. CHAN
Manager, Information & Env. Analysis
816 State Street
Santa Barbara, CA 93102

CHANG, F. H.
General Dynamics Corp., Fort Worth Div.
ATTN: MR. FRANCIS H. CHANG
Sr. Eng. Spec., Matls Res. Lab
M/S 5984
P.O. Box 748
Fort Worth, TX 76101

CHARTERS, M. L.
General Dynamics, Pomona Div.
ATTN: MR. M. L. CHARTERS
Mail Stop 4-26
Box 2507
Pomona, CA 91766

CHEAL, J.
OMNI Spectra, Inc.
ATTN: MR. JAMES CHEAL
Vice President
2626 S. Hardy Drive
Tempe, AZ 85282

CHENG, H. M.
Office of Chief, Naval Operations
ATTN: MR. H. M. CHENG
Assistant for Ships & Vehicles
(OP 987)
Washington, DC 20350

CHILDS, J. J.
James J. Childs Associates, Inc.
ATTN: MR. JAMES J. CHILDS
President
803 Timber Branch Parkway
Alexandria, VA 22302

CHRISTOPHER, J.
Metcut Research Associates, Inc.
ATTN: MR. JOHN CHRISTOPHER
Manager, Machinability
3980 Rosslyn Drive
Cincinnati, OH 45209

CHURCH, J.
IIT Research Institute
ATTN: MS. JANIS CHURCH
Manager
10711 S. Hoyne Avenue
Chicago, IL 60643

CIVILIKIS, F.
US Army Natick R&D Command
ATTN: MR. FRANK CIVILIKIS
ATTN: DRDNA-EM
Natick, MA 01760

CLARK, B. B.
Magnavox Government & Ind. Elec.
ATTN: MR. BILL B. CLARK
1313 Production Road
Ft. Wayne, IN 46808

COATS, G. C.
McDonnell Douglas Astronautics Co.
ATTN: MR. G. C. COATS
Manager, Mfg. R&D
107/3/367
P.O. Box 516
St. Louis, MO 63166

COCHRANE, F.
Naval Air Systems Command
ATTN: MR. FREDERIC COCHRANE
Aerospace Engineer
Washington, DC

COCKERHAM (USA RET), BG S. G.
ATS
ATTN: BG SAMUEL G. COCKERHAM (USA RET)
512 N. Washington Street
Alexandria, VA 22314

COLANGELO, V.
Benet Weapons Laboratory (ARRADCOM)
ATTN: DR. V. COLANGELO
DRDAR-LCB-S
Watervliet, NY 12189

COLE, C. H.
Vought Corporation
ATTN: MR. C. H. COLE
Mgr. Adv. Mfg. Tech. Mktg.
MS 2-15000
P.O. Box 225907
Dallas, TX 75265

COLEMAN, B.
Battelle-Northwest
ATTN: MR. BILL COLEMAN
Mgr., Manufacturing Technology
Richland, WA 99352

COLLARD, J.
Raytheon Company
ATTN: MR. JACQUES COLLARD
Tech. Dir., Vice President's Staff
M/S 01, Dept. 3010
Foundry Avenue
Waltham, MA 02154

COLONEY, W. H.
W. H. Coloney Company, Inc.
ATTN: MR. WAYNE H. COLONEY
P.O. Box 5258
Tallahassee, Florida 32301

CONNOLLY, BG J.
HQ, US Air FOrce
ATTN: BG J. CONNOLLY
Director, Contracting & Acq. Policy
AF/RDC
Pentagon
Washington, DC 20330

COOK, K. B.
Microelectronics Engineering Corp.
ATTN: DR. K. B. COOK
P.O. Box 1209
Auburn, AL 36830

CRIMMINS, P. P.
Aerojet Tactical Systems
ATTN: MR. PHILLIP P. CRIMMINS
Mgr., Adv. Mfg. Eng.
Building 05025
P.O. Box 13400
Sacramento, CA 95813

CRISCUOLO, E.
Naval Surface Weapons Center
ATTN: MR. EDWARD CRISCUOLO
Code R34, Building 70-112
White Oak
Silver Spring, MD 20910

CROOKS, H. R.
US Army Materiel Dev. & Read. Cmd.
ATTN: MR. H. ROBERT CROOKS
DRCPP-I
5001 Eisenhower Avenue
Alexandria, VA 22333

CRUDO, ALAN H.
US Army Matls & Mech Res Ctr
ATTN: MR. ALAN H. CRUDO
DRXMR-PMT
Watertown, MA 02172

CSASZAR, B. J.
General Dynamics
ATTN: MR. BRUCE J. CSASZAR
333 W. First Street
Suite 236
Dayton, OH 45402

CULP, J. D.
McDonnell Douglas Astronautics Co.
ATTN: MR. JOHN D. CULP
Dept. E457, Bldg. 106/2/PST,B10
P.O. Box 516
St. Louis, MO 63166

CWIERTNY, A. J.
McDonnell Douglas Astronautics Co.
ATTN: MR. A. J. CWIERTNY
Mail Stop 13-3
5301 Bolsa Avenue
Huntington Beach, CA 92647

DANCE, W. E.
Vought Corporation
ATTN: MR. WILLIAM E. DANCE
Manager, Neutron Radiography
Mail Stop R92200
Box 226144
Dallas, TX 75266

DAVIDSON, E.
Office of Asst. Sec. of Army for RDA
ATTN: MR. EUGENE DAVIDSON
Asst. Dep. for Ammo. & Ind. Preparedness
Room 2E661
Pentagon
Washington, DC 20310

DAVIDSON, DR. J.
Microelectronics Engineering Corp.
ATTN: DR. JIM DAVIDSON
Vice President, Operations
P.O. ox 1209
Auburn, AL 36830

DAVIES, SR., A. P.
Motorola Government Electronics Div.
ATTN: MR. ALEXANDER P. DAVIES, SR.
645 W. 24th Street
GS-61
Tempe, AZ 85282

DAVIES, L. T.
General Motors Corporation
ATTN: LYNN T. DAVIES
Technical Liaison, Mfg. Dev.
General Motors Technical Center
Warren, MI 48090-9040

DAVIS, G. L.
General Dynamics Corp-Ft. Worth Div.
ATTN: MR. GRANT L. DAVIS
Mail Stop 6215
P.O. Box 748
Ft. Worth, TX 76101

DAVIS, R.
Chesebrough Ponds, Inc.
ATTN: MR. RAY DAVIS
Dir., Corporate Advanced Tech.
Lohn Street
Clinton, CT 06413

DAVIS, R. P.
Virginia Polytech Inst. & St. Univ.
ATTN: MR. ROBERT P. DAVIS
Dept. of Ind. Eng. & Oper. Research
Whittemore Hall
Blacksburg, VA 24061

DEAM, J. B.
National Machine Tool Builders Assoc.
ATTN: MR. JOHN B. DEAM
Technical Director
7901 Westpark Drive
McLean, VA 22102

DELANEY, S.
ITT Gilfillan
ATTN: MR. SAM DELANEY
766 Shrewsbury Avenue
Tinton Falls, NJ 07724

DEL GUERCIO, A. V.
McDonnell Douglas Astronautics
ATTN: MR. A. V. DEL GUERCIO
Branch Manager, Production Eng.
Mail Stop 104
P.O. Box 600
Titusville, FL 32780

DeMASSI, G.
US Army Armament R&D Command
ATTN: MR. GEORGE DeMASSI
DRDAR-QAF-A
Product Assurance Directorate
Bldg. 62
Dover, NJ 07801

DEVOE, G.
Mun. Prod. Base Mod. Agency
ATTN: MR. GEORGE DEVOE
SARPM-PBM
Building 171
Dover, NJ 07801

DiBENEDETTO, J.
Cdr, Rock Island Arsenal
ATTN: MR. JOSEPH DiBENEDETTO
SARRI-ENM
Engineering Directorate
Rock Island, IL 61299

DiBENEDETTO, V.
AF Wright Aeronautical Laboratory
ATTN: MR. VINCENZO DiBENEDETTO
AFWAL/MLTN
Wright-Patterson AFB, OH 45433

DOHERTY, S.
US Army Matls. & Mech. Res. Ctr.
ATTN: MR. S. DOHERTY
DRXMR-E
Watertown, MA 02172

DONLAN, V. L.
Hanscom Air Force Base
ATTN: MR. VINCENT L. DONLAN
ESD/TOM, Mail Stop 36
Hanscom Air Force Base
Bedford, MA 01731

DOWNER, C. P.
Off of Under Sec of Defense (R&E, AP)
ATTN: MR. CHARLES P. DOWNER
Dir., Defense Industrial Resources Office
Two Skyline Place, 14th Floor
5203 Leesburg Pike
Falls Church, VA 22041

DRASCHIL, T. E.
Naval Sea Systems Command
ATTN: MR. THOMAS E. DRASCHIL
Program Manager for Mfg. Tech.
CODE 05R23
Washington, DC 20362

DRISH, J. C.
Singer - Kearfott Division
ATTN: MR. JOHN C. DRISH
Vice President, Operations
Mail Stop 1AA11
1150 McBride Avenue
Little Falls, NJ 07424

DUTCHYSHYN, COL H. V.
CDR, Mun. Prod. Base Mod. Agency
ATTN: COL HARRY V. DUTCHYSHYN
Building 171
Dover, New Jersey 07801

EASTERLING, A. E.
Applied Tech. Lab (AVRADCOM)
ATTN: MR. ALBERT E. EASTERLING
DAVDL-U-TAP
Fort Eustis, VA 23604

EASTWOOD, M.
McDonnell Douglas Automation Co.
ATTN: MS. MARGARET EASTWOOD
Dept. K163, Bldg. 2, Room 129
P.O. Box 516
St. Louis, MO 63166

EBIHARA, DR. W. T.
US Army Armament R&D Command
ATTN: DR. WILLIAM T. EBIHARA
ATTN: DRDAR-SCM-P
Dover, NJ 07801

EDMISTON, W. A.
Jet Propulsion Lab
ATTN: MR. WILLIAM A. EDMISTON
Bldg. 506, Room 432
4800 Oak Grove Drive
Pasadena, CA 91103

EGAN, G. S.
Hughes Aircraft Company
ATTN: MR. GEORGE S. EGAN
B117/12
P.O. Box 90515
Los Angeles, CA 90009

ENNIS, G.
Vough Corporation
ATTN: MR. GERALD ENNIS
Director of CAD/CAM Programs
P.O. Box 225907
Mail Stop 2-20,000
Dallas, TX 75265

ERBACHER, MAJ J.
AF Wright Aeronautical Lab
ATTN: MAJ JOHN ERBACHER
AFWAL/MLTE, Electronics Br.
Wright-Patterson AFB, OH 45433

ERICKSON, DR. J. S.
General Electric Company
ATTN: DR. JOHN S. ERICKSON
Mgr, Matls & Processing Dev
M/S M82
Evendale Plant
Cincinnati, OH 45215

ERWIN, DR. L.
Massachusetts Institute of Technology
ATTN: DR. LEWIS ERWIN
Assistant Professor
Room 35-008
Cambridge, MA 02139

FAHEY, N. H.
US Army Matls & Mech Research Center
ATTN: MR. N. H. FAHEY
Chief, MTTD Division
ATTN: DRXMR-M
Watertown, MA 02172

FARROW, RAYMOND L.
US Army Matls & Mech Res Ctr
ATTN: MR. RAYMOND L. FARROW
Chief, Tech. Plan. & Mgmt. Div.
DRXMR-PMT
Watertown, MA 02172

FEDDELER, A. J.
US Army Communications R&D Command
ATTN: MR. ALBERT J. FEDDELER
DRDCO-OP-P-G
Plans and Operations Directorate
Fort Monmouth, NJ 07703

FENTOR, J.
AF Wright Aeronautical Laboratories
ATTN: MR. JOHN FENTOR
AFWAL/MLTE, Electronics Branch
Wright-Patterson AFB, OH 45433

FERDERBER, J.
Hughes Aircraft Company
ATTN: MR. JOSEPH FERDERBER
Vice President, Mfg.
Bldg. 1, A192
Centinela Avenue & Teale St.
Culver City, CA 90230

FIELDS, JR., P. E.
Lockheed Missiles & Space Company, Inc.
ATTN: MR. PAUL E. FIELDS, JR.
Manager, Microelectronics
86-16/B-151
1111 Lockheed Way
Sunnyvale, CA 94086

FIORENTINO, R. J.
Battelle-Columbus Laboratories
ATTN: MR. ROBERT J. FIORENTINO
Program Manager
505 King Avenue
Columbus, OH 43201

FORD, R.
Vought Corporation
ATTN: MR. REX FORD
Manager, Mfg. Tech.
Unit 2-22300
P.O. Box 225907
Dallas, TX 75265

FORTGANG, H. R.
Jet Propulsion Laboratory
ATTN: MR. HERBERT R. FORTGANG
Mail Stop 510/260
4800 Oak Grove Drive
Pasadena, CA 91103

FRANK, G. A.
Defense Logistics Agency
ATTN: MR. GORDON A. FRANK
DoD Product Eng. Services Office
Cameron Station
Alexandria, VA 22314

FREEDMAN, A. H.
Northrop Corporation
ATTN: MR. ALLAN H. FREEDMAN
Aircraft Division
Mail Stop 3871-62
3901 W. Broadway
Hawthorne, CA 90250

FRENCH, DR. R. D.
US Army Matls. & Mech. Res. Ctr.
ATTN: DR. ROBERT D. FRENCH
DRXMR-K
Watertown, MA 02172

FRY, L. M.
Aeronautical Systems Division
ATTN: MR. LARRY M. FRY
Dep. Dir., Mfg. & Quality Assurance
ATTN: ASD/AFD
Wright-Patterson AFB, OH 45433

GAGNE, R.
US Army Matls. & Mech. Res. Ctr.
ATTN: MR. ROGER GAGNE
DRXMR-ER
Watertown, MA 02172

GAGNON, F. L.
Kollsman Instrument Company
ATTN: MR. F. L. GAGNON
Vice President & General Mgr
Mail Stop VP-1
Daniel Webster Highway South
Merrimack, NH 03054

AD-A105 209 DEPARTMENT OF DEFENSE WASHINGTON DC F/G 13/8
PROCEEDINGS OF THE ANNUAL TRI-SERVICE MANUFACTURING TECHNOLOGY --ETC(U)
OCT 80

UNCLASSIFIED NL

4 OF 4
AD A
105 209

END
DATE
FILMED
10-81
DTIC

GALIE, T.
Naval Ship Systems Eng. Station
ATTN: MR. THOMAS GALIE
CODE 052D
Building 633
Philadelphia Naval Base
Philadelphia, PA 19112

GALLAUGHER, J.
Dir., US Army Ind. Base Eng. Activity
ATTN: MR. JAMES GALLAUGHER
DRXIB
Rock Island, IL 61299

GAMBLE, R. A.
Naval Ocean Systems Center
ATTN: MR. R. A. GAMBLE
Mail Stop 9204
271 Catalina Boulevard
San Diego, CA 92152

GARCIA, F. H.
Mechanical Technology Inc.
ATTN: MR. FRED H. GARCIA
Marketing Rep.
3833 Louis Street
St. Louis, MO 63166

GARDNER, E.

ATTN: MR. EDSON GARDNER
532 Meadow Hall Drive
Rockville, MD 20815

GARSON, H. J.
US Army Electronics R&D Command
ATTN: MR. HAROLD J. GARSON
DRDEL-ED
2800 Powder Mill Road
Adelphi, MD 20783

GASCHNIG, G. R.
Raytheon Company
ATTN: MR. G. R. GASCHNIG
Mail Stop M29-5
Hartwell Road
Bedford, MA 01730

GEPHARDT, JR., W. E.
Frontier Bronze Corp.
ATTN: MR. WILLIAM GEPHARDT, JR.
President
4870 Packard Road
Niagara Falls, NY 14304

GERSON, H.
U.S. Army Mun Prod Base Mod Agency
ATTN: MR. H. GERSON
SARPM-PBM-MF
Dover, NJ 07801

GILBERT, R. L.
DoD Product Engineering Service Office
ATTN: MR. RAY L. GILBERT
Cameron Station
Alexandria, VA 22314

GIORDANO, R. A.
Naval Matl Cmd Ind Res Det
ATTN: MR. RICHARD A. GIORDANO
CODE 04X2
Building 75-2
Philadelphia Naval Base
Philadelphia, PA 19112

GLICK, V. M.
Lockheed Missiles & Space Co.
ATTN: MR. VERNON M. GLICK
Mgr., Advanced Manufacturing Technology
0/71-33, B/103
1111 Lockheed Way
Sunnyvale, CA 94086

GLICKSMAN, DR. R.
RCA
ATTN: DR. R. GLICKSMAN
Manager, Government Marketing
MS 442
Route 202
Sommerville, NJ 08876

GODINO, A. D.
Hughes Aircraft Company
ATTN: MR. A. D. GODINO
Manager, Marketing Services
Mail Stop 262/B96
Canoga Park, CA 91304

GOLDHAR, DR. J. D.
National Research Council
ATTN: DR. JOEL D. GOLDHAR
Executive Director,
Manufacturing Studies Board
2101 Constitution Avenue, N.W.
Washington, DC 20418

GONZALEZ, L.
General Electric-TEMPO
ATTN: LOUIS GONZALEZ
Senior Data Analyst
Center for Advanced Studies
816 State Street
Santa Barbara, CA 93101

GOODMAN, S.
Cdr., US Army Tank-Automotive Command
ATTN: MR. SAM GOODMAN
DRSTA-RCKM
Warren, MI 48090

GOREN, M.
Israel Aircraft Industries Ltd.
ATTN: MR. MORDECHAI GOREN
Technical Assistant to President
Suite 1923
1700 N. Moore Street
Arlington, VA 22209

GOSNELL, R. B.
King Mar Laboratories
ATTN: MR. REX B. GOSNELL
9929C Hibert Street
San Diego, CA 92131

GRAHAM, H.
AF Wright Aeronautical Lab
ATTN: DR. H. GRAHAM
AFWAL/MLLM
Wright-Patterson AFB, OH 45433

GRASSI, R. A.
Ford Aerospace & Comm. Corp.
ATTN: MR. RALPH A. GRASSI
Ford Road
Newport Beach, CA 92660

GREEHAN, F. J.
SRI International
ATTN: MR. FRANCIS J. GREEHAN
Dir., WDC Tech & Innovation Mgmt Dept
1611 No. Kent Street, 4th Floor
Rosslyn, VA 22209

GREEN, C. J.
AVCO, Aerostructures Div.
ATTN: MR. C. J. GREEN
Director, Marketing
P.O. Box 210
Nashville, TN 37202

GREESON, J. B.
Hughes Aircraft Co.
ATTN: MR. JOSEPH B. GREESON
Mail Stop 808 F2B
P.O. Box 11337
Tucson, AZ 85734

GRIDER, E. E.
Engelhard Industries
ATTN: MR. ERNEST E. GRIDER
General Manager
Route 152
Plainville, MA 02763

GRIFFIN, DAROLD L.
US Army Matl Dev & Read Cmd
ATTN: MR. DAROLD L. GRIFFIN
5001 Eisenhower Avenue
Alexandria, VA 22333

GROBE, A. H.
TRW, Inc.
ATTN: MR. ARTHUR H. GROBE
Director, Materials Technology
M/S T/M 3147
23555 Euclid Avenue
Cleveland, OH 44117

GROLLO, R. P.
Naval Ordnance Station
ATTN: MR. RICHARD P. GROLLO
Mfg. Tech. Branch
CODE 2043-MDS25
Louisville, KY 40214

GROSS, DONALD
US Army Materiel Dev. & Read. Cmd
ATTN: MR. DONALD GROSS
ATTN: DRCMT
Office of Manufacturing Technology
5001 Eisenhower Avenue
Alexandria, VA 22333

GUTHRIE, GEN JOHN R.
Cdr, US Army Matl Dev & Read Command
ATTN: GEN JOHN R. GUTHRIE
DRCCG
5001 Eisenhower Avenue
Alexandria, VA 22333

GUTTWEIN, H.
US Army Armament R&D Command
ATTN: MR. HANS GUTTWEIN
DRDAR-QAF-I
Building 62
Dover, New Jersey 07860

GUYTON, R. D
Universal Technology Corp.
ATTN: MR. ROBERT D. GUYTON
President
A-21
1656 Mardon Drive
Dayton, OH 45432

GYOROG, DR. D. A.
US Army Armament R&D Command
ATTN: DR. DONALD A. GYOROG
Deputy Director, FC&SCWSL
Dover, NJ 07801

HALBIG, L.
Naval Avionic Center
ATTN: MR. LARRY HALBIG
Dept. 216
6000 East 21st Street
Indianapolis, IN 46218

HAMILL, A. T.
Westinghouse-Defense Center
ATTN: MR. AL T. HAMILL
Advisory Engr, Mfg. Planning
M/S V-14
P.O. Box 746
Baltimore, MD 21203

HANDLER, H.
US Army Materiel Dev. & Read. Cmd
ATTN: MR. HENRY HANDLER
Technical Relations Consultant
5001 Eisenhower Avenue
Alexandria, VA 22333

HANDMAN, S.
AVCO-Systems Div.
ATTN: MR. SEYMOUR HANDMAN
Chief of Mfg. & Proc.
201 Lowell Street
Wilmington, MA 01887

HARKINS, W. D.
Systems Consultants, Inc.
ATTN: MR. WILLIAM D. HARKINS
Senior Program Engineer
Suite 300
Pennsylvania Avenue, N.W.
Washington, DC 20007

HARRIS, T.
Ford Aerospace & Communications Corp.
ATTN: MR. TONY HARRIS
300 Renaissance Center
20th Floor
Detroit, MI 48324

HART, S. S.
US Army Armament R&D Command
ATTN: MR. STANLEY S. HART
DRDAR-TSF-Q
Building 61N
Dover, New Jersey 07801

HARTIN, S. S.
Microelectronics Engineering Corp.
ATTN: MR. SAM S. HARTIN
P.O. Box 1209
Auburn, AL 36830

HARTMAN, D. B.
Hughes Aircraft Company
ATTN: MR. DALE B. HARTMAN
Corporate Dir. of Manufacturing
Building 100, MS A788
P.O. Box 90515
Los Angeles, CA 90009

HARY, L. B.
Air Force Logistics Command
ATTN: MR. L. B. HARY
AFLC/MAXT
Wright-Patterson AFB, OH 45433

HAUSCHILD, D. L.
Honeywell, Inc.
ATTN: MA. DAN L. HAUSCHILD
Senior Materials Eng.
M/S Mn 11-2160
600 2nd Street NE
Hopkins, MN 55343

HAYES, DR. G. A.
Cdr, Naval Weapons Center
ATTN: DR. G. A. HAYES
CODE 3624
China Lake, CA 93555

HAYNES, MAJ G. W.
AF Wright Aeronautical Lab
ATTN: MAJ GERALD W. HAYNES
ICAM Deputy Program Manager
AFWAL/MLTC
Wright-Patterson AFB, OH 45433

HAYS, G. A.
U.S. Air Force
ATTN: MR. GILBERT A. HAYS
AFPRO/PD
P.O. Box 371
Fort Worth, TX 76101

HAZEN, C. A.
Naval Weapons Center
ATTN: MR. CLYDE A. HAZEN
CODE 36404
China Lake, CA 93555

HENDERSON, J.
Westinghouse-Defense
ATTN: MR. JAMES HENDERSON
P.O. Box 746
Mail Stop 1700
Baltimore, MD 21202

HENDERSON, L. D.
Naval Ordnance Station
ATTN: MR. LARRY D. HENDERSON
Code PM5B
Indian Head, MD 20640

HENDRICKS, COL R. J.
USAF, Aeronautical Systems Division
ATTN: COL ROY J. HENDRICKS
Director Manufacturing/QC
Wright-Patterson AFB, OH 45433

HERNDON, C. F.
General Dynamics, Ft. Worth Div.
ATTN: MR. CHARLES F. HERNDON
Manager of Structural Design
Mail Stop 2826
P.O. Box 748
Fort Worth, TX 76101

HERSAM, R. A.
US Army Matl. Dev. & Read. Cmd.
ATTN: MR. RICHARD A. HERSAM
5001 Eisenhower Avenue
Alexandria, VA 22333

HEVERT, C. H.
Singer Company-Kearfott Division
ATTN: MR. C. H. HEVERT
Director, Production Engineering
Mail Stop 1BA39
1150 McBride Avenue
Little Falls, NJ 07424

HILCHEY, R. E.
Rockwell International
ATTN: MR. R. E. HILCHEY
Vice Pres., Prod. Operations
Mail Stop 407-400
P.O. Box 10462
Dallas, TX 75207

HILDICK, JR., T. E.
Honeywell, Inc.
ATTN: MR. THOMAS E. HILDICK, JR.
Mgr, Adv Mfg Tech, Avionics Div
M/S 330-5
13350 U.S. Highway 19
St. Petersburg, FL 33733

HILL, J. E.
International Harvester
ATTN: MR. JAMES E. HILL
Mgr., Mfg. Tech., Composite Matls
Science and Technology Laboratory
7 S. 600 County Line Road
Hinsdale, IL 60521

HILL, R.
Naval Electronic Systems Cmd
ATTN: MR. RAYMOND HILL
NAVELEX
Washington, DC 20360

HINZ, W.
US Army Armament Mat. Read. Cmd
ATTN: MR. WALTER HINZ
Industrial Specialist
DRSAR-IRW-T
Rock Island, IL 61299

HITTNER, H.
Naval Matl Cmd Ind Res Det
ATTN: MR. HOWARD HITTNER
Code 04X25
Philadelphia Naval Base
Building 75-2
Philadelphia, PA 19112

HOCK, R. J.
Hughes Aircraft Company
ATTN: MR. R. J. HOCK
Tuscon Manufacturing Division
Bldg. 801, 1-17
P.O. Box 11337
Tuscon, AZ 85734

HOKE, J. U.
Harry Diamond Laboratories
ATTN: MR. JULIUS U. HOKE
DELHD-PO-P
2800 Powder Mill Road
Adelphi, MD 20783

HOLDEN, W.
Naval Material Command
ATTN: MR. WILLIAM HOLDEN
MAT 064
Washington, DC 20360

HOLLICK, CAPT F.
HQ, Naval Material Command
ATTN: CAPT FRED HOLLICK
Director of Manufacturing Technology
MAT 064
Washington, DC 20360

HOLMES, W. H.
Wyman-Gordon Company
ATTN: MR. WILLIAM H. HOLMES
Mgr. Mkt. Res & Dev.
244 Worcester Street
North Grafton, MA 01536

HOPPIN, III, G.
AiResearch Manufacturing Co. of Arizona
ATTN: MR. GEORGE HOPPIN, III
Mail Stop 503-4Y
P.O. Box 5217
Phoenix, AZ 85010

HORPATH, COL R.
US Army Materiel Dev. & Read. Cmd
ATTN: COL RICHARD HORPATH
5001 Eisenhower Avenue
Alexandria, VA 22333

HOUSER, J. E.
Rockwell International
ATTN: MR. JAMES E. HOUSER
Dir., Mfg., Electronic Oper.
M/S 407-400
P.O. Box 10462
Dallas, TX 75207

HOWARD, MAJ W.
Aeronautical Systems Division
ATTN: MAJ WILLIAM HOWARD
Director, Manufacturing/QA
ASD/AED
Wright-Patterson AFB, OH 45433

HUBER, J. G.
Grumman Aerospace Corp.
ATTN: MR. JOHN G. HUBER
Section Head
M/S A04-12
New South Road
Bethpage, NY 11714

HUBLER, G. K.
Naval Research Laboratory
ATTN: MR. GRAHAM K. HUBLER
Mail Stop 6670
Washington, DC 20375

HUNT, R. C.
Numerical Society Society
ATTN: MR. RONALD C. HUNT
Executive Vice President
519 Zenith Drive

HUSSA, R. W.
Bell Aerospace Textron
ATTN: MR. ROBERT W. HUSSA
Vice President-Manufacturing
M/S C-26
Post Office Box One
Buffalo, NY 14240

HUSSEY, J.
Solar Turbines International
ATTN: MR. JOHN HUSSEY
Manager, Program R&D, MS R-1
2200 Pacific Highway
PO Box 80966
San Diego, CA 92138

IDES, M.
US Army Comm & Elec Matl Read Cmd
ATTN: MR. MARTIN IDES
Chief, Readiness Programs Div.
DRSEL-LE-R
Fort Monmouth, NJ 07703

IPPOLITO, D.
Watervliet Arsenal
ATTN: MR. DOM IPPOLITO
SARWV-ODP-S, Bldg. 35
Watervliet, NY 12189

IVANKO, T.
AVCO-Lycoming
ATTN: MR. THEODORE IVANKO
Vice President, Eng. Prod. Liaison and Experimental Manufacturing
550 South Main Street
Stratford, CT 06497

JACAWAY, W. H.
Boeing Aerospace Company
ATTN: MR. W. H. JACAWAY
Customer R&D Requirements Mgr.
Mail Stop 84-68
P.O. Box 3999
Seattle, WA 98124

JACKSON, R. H.
Mechanical Technology Inc.
ATTN: MR. RICHARD H. JACKSON
Marketing Mgr., Research & Technology
968 Albany-Shaker Road
Latham, NY 12110

JACOBSON, DR. M. I.
Lockheed Missiles & Space Company
ATTN: DR. MARTIN I. JACOBSON
0/86-33, B151
P.O. Box 504
Sunnyvale, CA 94086

JACOBSON, R. H.
GATX/GARD Inc.
ATTN: MR. R. H. JACOBSON
7449 N. Natchez
Niles, IL 60648

JENKINS, M.
Beloit Corporation
ATTN: MR. MONTY JENKINS
Paper Machinery Division
1 St. Lawrence Avenue
Beloit, WI 53511

JENKINS, W. H.
Naval Air Rework Faicility
ATTN: MR. WILBUR H. JENKINS
Advance Planning & Technology Office 003
Mail Stop 09
Marine Corps Air Station
Cherry Point, NC 28533

JENSEN, D. M.
Honeywell, Inc.
ATTN: MR. DAVID M. JENSEN
Mgr, AMT, Avionics Div
M/S MN15-2390
1625 Zarthan Avenue
St. Louis Park, MN 55416

JOHN, DR. J.
IRT Corporation
ATTN: DR. JOSEPH JOHN
Vice President
P.O. Box 80817
San Diego, CA 92138

JOHNSON, C. A.
Naval Weapons Center
ATTN: MR. C. A. JOHNSON
CODE 3624
China Lake, CA 93555

JOHNSON, H. A.
AF Wright Aeronautical Laboratory
ATTN: MR. HENRY A. JOHNSON
AFWAL/MLTM
Wright-Patterson AFB, OH 45433

JOHNSON, R. L.
Sperry Univac, Defense Sys. Div.
ATTN: MR. RICHARD L. JOHNSON
Director, Mfg. Planning
Mail Stop U2P25
P.O. Box 3525
St. Paul, MN 55104

JONES, R.
Naval Air Systems Command
ATTN: MR. R. JONES
AIR 51627C
Washington, DC 20361

JONES, R. L.
Northrop Corp-Aircraft Div.
ATTN: MR. RICHARD L. JONES
Mgr., Matls & Proc Res & Tech
M/S 3870-62
3901 W. Broadway
Hawthorne, CA 90250

KAHLES, DR. J. F.
Metcut Research Assoc., Inc.
ATTN: DR. JOHN F. KAHLES
Senior Vice President
3980 Rosslyn Drive
Cincinnati, OH 45209

KAHNKE, M.
Bendix Corporation
ATTN: MR. MARK KAHNKE
Manufacturing Manager
1911 N. Ft. Meyer Drive
Arlington, VA 22209

KAPLOWITZ, S.
US Army Armament R&D Command
ATTN: MR. S. KAPLOWITZ
DRDAR-LCM-E
Building 3305
Dover, New Jersey 07801

KASCHAK, J. M.
Mun. Prod. Base Mod. Agency
ATTN: MR. JOHN M. KASCHAK
SARPM-PBM-J
D er, NJ 07801

KATZIN, L.
Aerospace Corporation
ATTN: MR. LEONARD KATZIN
Manager, Production Engineering
Mail Stop A2/1019E
P.O. Box 92957
Los Angeles, CA 90009

KAUFMANN, H.
Project Manager
ATTN: MR. HAROLD KAUFMANN
5280 Northeast Main Street
Minneapolis, MN 55421

KAYAFAS, P.
Hazeltine Corporation
ATTN: MR. PETE KAYAFAS
2001 Jefferson Davis Hwy
Suite 811
Arlington, VA 22202

KELLER, R. E.
Allis-Chamers
ATTN: MR. RALPH E. KELLER
Mgr. Govt. & Comm. Marketing
P.O. Box M101
York, PA 17402

KELLEY, A. W.
Honeywell, Inc.
ATTN: MR. A. W. KELLEY
Director of Operations
Mail Stop 139-I
P.O. Box 11568
St. Petersburg, FL 33733

KELLEY, E.
Naval Ocean Systems Center
ATTN: MR. EUGENE KELLEY
Mail Stop 9255
271 Catalina Boulevard
San Diego, CA 921521

KELLNER, J.
Hamilton Standard
ATTN: MR. JORDAN KELLNER
Mail Stop 2-M-11
Bradley Field Road
Windsor Locks, CT 06096

KELLY, J. F.
US Army Communications R&D Command
ATTN: MR. JAMES F. KELLY
DRDCO-PE-EC-1
Ft. Monmouth, NJ 07703

KEMLER, M. P.
Naval Matl Cmd Ind Resources Detachment
ATTN: MR. MICHAEL P. KEMLER
CODE 989.2, Bldg. 1029
Philadephia Naval Shipyard
Philadelphia, PA 19112

KEMPER, R. S.
Battelle-Northwest
ATTN: MR. ROBERT S. KEMPER
R&D Manager
Mail Stop 306W BLDG
Richland, WA 99352

KENNARD, R. L.
AF Wright Aeronautical Laboratory
ATTN: MR. RUSSELL L. KENNARD
AFWAL/MLTM
Wright-Patterson AFB, OH 45433

KENNEY, G.
Mass. Institute for Tech.
ATTN: MR. GEORGE KENNEY
Room 4-415
Cambridge, MA 02139

KEY, J. A.
US Army Electronics R&D Cmd
ATTN: MR. JOSEPH A. KEY
DELET-RM
Electronics Technology & Devices Lab
Fort Monmouth, NJ 20783

KING, M. H.
Department of Commerce
ATTN: MS. MARGERY H. KING
Acting Director, COUFT
Room 3877
Washington, DC 20230

KISNER, W.
Rock Island Arsenal
ATTN: MR. WALTER KISNER
Dir. of Engineering
SARRI-EN
Rock Island, IL 61299

KITCHINS, W.
Warner Robbins Air Logistics Center
ATTN: MR. WILLIAM KITCHINS
WR-ALC/MASE
Robbins AFB, GA 31098

KLEBACK, T. A.
HQ, Naval Material Command
ATTN: MR. THOMAS A. KLEBACK
MAT 08L2
Washington, DC 20360

KLEBE, R. L.
Pratt & Whitney Aircraft Group
ATTN: MR. RICHARD L. KLEBE
Prog. Mgr., Gov Contracts
M/S M-06
P.O. Box 2691
West Palm Beach, FL 33402

KLEMOW, M.
Israel Aircraft Industries, Intl.
ATTN: MR. MARV KLEMOW
Director, Washington Office
1700 N. Moore Street, Suite 1923
Arlington, VA 22209

KLIMAN, DR. M.
Army Materials & Mechanics Research Center
ATTN: DR. MORTON KLIMAN
Army Materials & Mechanics Res. Ctr.
Watertown, MA 02172

KLINEFELTER, P.
Defense Technical Info Center
ATTN: MR. PAUL KLINEFELTER
Deputy Director
Data Base Services
Cameron Station
Alexandria, VA 22314

KOHLHORST, D. P.
Babcock & Wilcox
ATTN: MR. DARREL P. KOHLHORST
Manager, New Products
Code 34
NNFD, P.O. Box 785
Lynchburg, VA 24505

KOLIS, K.
Mun. Prod. Base Mod. Agency
ATTN: MR. KALMAN KOLIS
Chief, Metal Parts Division
SARPM-PBM-MC
Dover, New Jersey 07801

KOLLAR, W. L.
Naval Ship Systems Eng. Station
ATTN: MR. WALTER L. KOLLAR
Mail Stop 035.1
Philadelphia, PA 19112

KOPPENAAL, DICK
US Army Material Dev. & Read. Cmd
ATTN: MR. DICK KOPPENAAL
DRCMT
Office of Manufacturing Technology
5001 Eisenhower Avenue
Alexandria, VA 22333

KORNITZKY, MICHAEL A.
US Army Matls & Mech Res Ctr
ATTN: MR. MICHAEL A. KORNITZKY
DRXMR-PMT
Watertown, MA 02172

KOSTER, W. P.
Metcut Research Associates, Inc.
ATTN: MR. WILLIAM P. KOSTER
President
3980 Rosslyn Drive
Cincinnati, OH 45209

KOTAR, K.
General Electric
ATTN: MR. KERRY KOTAR
Manager, Production Program
Mail Stop 24021
1000 Western Avenue
Lynn, MA 01910

KOTLER, R.
US Army Missile Command
ATTN: MR. RICHARD KOTLER
DRSMI-ET
Redstone Arsenal, AL 35809

KOURCE, A.
US Army Ind. Base Eng. Activity
ATTN: MR. ANDREW KOURCE
DRXIB-MT
Rock Island, IL 61299

KRAJKOWSKI, E
US Army Armament R&D Command
ATTN: MR. EDWARD KRAJKOWSKI
DRDAR-LCM-SE
Dover, NJ 07801

KRAMER, J. D.
Boeing Commerical Airplane Co.
ATTN: MR. JOHN D. KRAMER
Automation Tech Mgr, Mfg. R&D
M/S 9R-35
P.O. Box 3707
Seattle, WA 98124

KUHL, G. E.
AF Wright Aeronautical Lab
ATTN: MR. G. EDWARD KUHL
AFWAL/MLPO
Wright-Patterson AFB, OH 45433

KUNG, J.
Harris Corp., PRD Electronics
ATTN: MR. JEFFREY KUNG
6801 Jericho Turnpike
Syosset, NY 11791

KURZ, W.
General Electric Company
ATTN: MR. WALTER KURZ
Mgr., Mfg. Dev. Oper., Aircraft Engine Gr.
Mail Stop 26804
1000 Western Avenue
Lynn, MA 01910

LAI, J.
Pearl Harbor Naval Shipyard
ATTN: MR. JOHN LAI
CODE 383
Pearl Harbor, HI 96960

LANASA, J.
Westinghouse Electric
ATTN: MR. JOHN LANASA
Nuclear Equipment Division
P.O. Box 355
Pittsburgh, PA 15230

LANGLOIS, A. P.
Northrop Corporation, Aircraft Div.
ATTN: MR. AL P. LANGLOIS
Director, New Tech. Acquisition
M/S 5071/61
3901 W. Broadway
Hawthorne, CA 90250

LAPERLE, C.
Honeywell, Inc.
ATTN: MR. CLAUDE LAPERLE
Mail Stop 330-5
13350 U.S. 19
St. Petersburg, FL 33733

LaPLANTE, R.
Varian Associates
ATTN: MR. ROGER LaPLANTE
8 Salem Road
Box 25
Beverly, MA 01915

LARSON, H. E.
Honeywell, Inc.
ATTN: MR. H. E. LARSON
Production Manager
MN11-2340
600 Second Street, N.E.
Hopkins, MN 55343

LASKEY, J. M.
RCA - Automated Systems
ATTN: MR. JOHN M. LASKEY
Manager, ATE Program Operations
Mail Stop 9-2
P.O. Box 588
Burlington, MA 01803

LAZAR, H. F.
US Army Armament R&D Command
ATTN: MR. HUGH F. LAZAR
Acting Director, Product Assurance
DRDAR-QA
Dover, NJ 07801

LEHN, DR. L. L.
Office of Under Sec of Defense (R&E,R&AT)
ATTN: DR. LLOYD L. LEHN
Assistant for Manufacturing Technology
Room 3E114
Pentagon
Washington, DC 20301

LELAND, J. M.
Naval Air Rework Facility
ATTN: MR. JAMES M. LELAND
CODE 640.1, Bldg. 3
Naval Air Station
North Island
San Diego, CA 92135

LENZ, G.
McDonnell Aircraft
ATTN: MR. GEORGE LENZ
Bldg. 27, S.BALC, Post 9BC
Box 516
St. Louis, MO 63066

LEPORE, J.
Mun. Prod. Base Mod. Agency
ATTN: MR. JOHN LEPORE
SARPM-PBM-L
Dover, NJ 07801

LEWIS, J. R.
Eglin Air Force Base
ATTN: MR. JAMES R. LEWIS
Director of Manufacturing
AD/PMD
Eglin AFB, FL 32542

LEWIS, L.
Doehler Jarvis, Div. of NL Industries
ATTN: MR. LARRY LEWIS
Customer Liaison Eng.
5400 N. Detroit Avenue
Toledo, OH 43612

LEWIS, DR. R.
US Army Matl. & Mech. Res. Ctr.
ATTN: DR. ROBERT LEWIS
DRXMR-RD
Watertown, MA 02172

LHERBIER, L. W.
Universal-Cyclops Corporation
ATTN: MR. LOUIS W. LHERBIER
Mgr, Powder Metallurgy
Universal-Cyclops Specialty Steel Div
Mayer Street
Bridgeville, PA 15017

LINDSEY, R. C.
IBM Corporation
ATTN: MR. RAYMOND C. LINDSEY
Executive Manager, Mfg. & Mfg. Eng.
Bodle Hill Road
Owego, NY 13827

LITTLE, G.
US Army Missile Command
ATTN: MR. GORDON LITTLE
DRSMI-RST, BO 5400
Redstone Arsenal, AL 35809

LIUZZI, L.
Benet Weapons Lab-ARRADCOM
ATTN: MR. LEONARD LIUZZI
Watervliet, NY 12189

LOMBARD, C. A.
Aeronautical Systems Division
ATTN: MR. CARL A. LOMBARD
Dep. Dir. of Mfg./QA for Prop.
ASD/YZD
Wright-Patterson AFB, OH 45433

LOVELL, R. D.
Northrop Corporation
ATTN: MR. ROBERT D. LOVELL
Vice President, New Program Dev.
Mail Stop 4960/83
3901 West Broadway
Hawthorne, CA 90250

LOWNDES, J. C.
Aviation Week
ATTN: MR. JAY C. LOWNDES
Engineering Editor
425 National Press Bldg.
Washington, D.C. 20045

MADDEN, P. A.
SKF Industries, Inc.
ATTN: MR. PATRICK A. MADDEN
Sr. Sales Manager
1100 First Avenue
King of Prussia, PA 19406

MADISON, S.
Whirlpool Corporation
ATTN: MR. SHANNON MADISON
Sr. Mfg. Res. Engr.
Monte Road
Benton Harbor, MI 49072

MAGUIRE, W. M.
Advanced Technology Systems
ATTN: MR. WILLIAM M. MAGUIRE
Director of Operations
17-01 Pollitt Drive
Fairlawn, NJ 07410

MAIONCHI, M. A.
Naval Plant Representative (SSPO)
ATTN: MR. MICHAEL A. MAIONCHI
SPL-632
P.O. Box 504
Sunnyvale, CA 94086

MAJUMDER, B.
General Dynamics, Convair Division
ATTN: MR. BOB MAJUMDER
Manager, Adv. Prog. Res. & Tech.
Mail Stop 41-3100
P.O. Box 80847
San Diego, CA 92138

MALLETS, LTC T. J.
Air Force Logistics Center
ATTN: LTC THOMAS J. MALLETS
AFLC/PMMP
Wright-Patterson AFB, OH 45433

MALM, D. C.
Booz, Allen & Hamilton
ATTN: MR. DAVID C. MALM
Principal
4330 East West Highway
Bethesda, MD 20014

MARKALL, J.
Naval Ocean Systems Center
ATTN: MR. JOHN MARKALL
Mail Stop 9243
271 Catalina Boulevard
San Diego, CA 92152

MARSICO, R. R.
Singer-Kearfott Division
ATTN: MR. RALPH R. MARSICO
Senior Management Analyst
M/S 03B31
1150 McBride Avenue
Little Falls, NJ 07424

MARTIN, P. E.
Microwave Associates, Inc.
ATTN: MR. PIERRE E. MARTIN
Director of Govt Relations
63 South Avenue
Burlington, MA 01803

MASON, J. C.
Bath Iron Works Corp.
ATTN: MR. JOHN C. MASON
Marad Program Manager
Dept. 56
700 Washington Street
Bath, ME 04530

MATSCHULAT, W. R.
Waukesha Division-Abex Corporation
ATTN: MR. W. R. MATSCHULAT
Vice President, General Manager
1300 Lincoln Avenue
Waukesha, WI 53186

MATTICE, J.
AF Wright Aeronautical Lab
ATTN: MR. JAMES MATTICE
AFWAL/MLT
Wright-Patterson AFB, OH 45433

MAURER, K.
Raytheon Company
ATTN: MR. KENNETH MAURER
Missile Systems Division
Mail Stop H2-46
Hartwell Road
Bedford, MA 01730

MAURER, R.
SKF Industries
ATTN: MR. ROBERT MAURER
1100 First Avenue
King of Prussia, PA 19406

MAXWELL, W.
Naval Air Rework Facility
ATTN: MR. WILLIAM MAXWELL
Director, Ind. Planning
CODE 640
Norfolk, VA 23511

MAY, C.
Lockheed Missiles & Space Company
ATTN: MR. CLAYTON MAY
B/170, 0/8633
P.O. Box 504
Sunnyvale, CA 94086

MAY, R. K.
Bell Helicopter/Textron
ATTN: MR. RICHARD K. MAY
Senior Vice President, Operations
Dept. 2A
P.O. Box 482
Fort Worth, TX 76101

McBURNEY, C. E.
US Army Ind. Base Eng. Activity
ATTN: MR. CHARLES E. McBURNEY
DRXIB-MT
Rock Island, IL 61299

MCCARTHY, J. N.
TRW Inc.
ATTN: MR. JOHN MCCARTHY
T/M 2110
23555 Euclid Avenue
Cleveland, OH 44117

McCARTY, F. H.
Raytheon Company
ATTN: MR. FRANK H. McCARTY
Director
141 Spring Street
Lexington, MA 02173

McCLOSKEY, P. F.
Electronic Industries Assoc.
ATTN: MR. PETER F. McCLOSKEY
President
2001 I Street, N.W.
Washington, D.C. 20006

McCLURE, V. W.
Texas Instruments, Inc.
ATTN: MR. VIRGE W. McCLURE
Corporate Mfg. Tech. Center
P.O. Box 225621
M/S 452
Dallas, TX 45265

McCRACKEN, J. R.
USAF Wright-Aeronautical Lab
ATTN: MR. JOHN R. McCRACKEN
AFWAL/MLTC
Dayton, OH 45433

McDONALD, M.
Honeywell, Inc.
ATTN: MR. MARK McDONALD
Defense Systems Division
MN-112320
600 Second Street, N.E.
Hopkins, MN 55343

McGLONE, S. A.
US Army Ind. Base Eng. Activity
ATTN: MR. STEVE A. McGLONE
DRXIB-MT
Rock Island, IL 61299

McINNIS, J. W.
Naval Material Command
ATTN: MR. JOHN W. McINNIS
Dep. Dir. for Manufacturing Technology
Crystal Plaza #5, Room 382
Jefferson Davis Highway
Arlington, VA 20360

McLAINE, D.
US AF Wright Aeronautical Laboratories
ATTN: MR. DAVID McLAINE
AFWAL-AADE
Wright-Patterson AFB, OH 45433

McROBERTS, G.
Lockheed Missiles & Space Co., Inc.
ATTN: MR. GREG McROBERTS
86-16/B-151
1111 Lockheed Way
Sunnyvale, CA 94086

MEADE, L. E.
Lockheed Georgia Company
ATTN: MR. L. E. MEADE
Department 72-77, Mail Zone 450
Marietta, GA 30063

MEINERT, R.
US Army Armament R&D Command
ATTN: MR. RICHARD MEINERT
DRDAR-LLU-M
Dover, NJ 07801

MERCER, JR., D. H.
RCA Corporation
ATTN: MR. D. HOWARD MERCER, JR.
Mgr., Prod. Prog. Projects -AEGIS
M/S 105-002
Bottom Landing Road
Morrestown, NJ 08034

MESSINA, F. J.
Grumman Aerospace Corp.
ATTN: MR. F. J. MESSINA
Vice President, Manufacturing
MS B-36-02
Bethpage, NY 11714

MESUK, R.
US Army Armament R&D Command
ATTN: MR. ROBERT MESUK
Chief, Value Engineering Div.
DRDAR-PMV
Building 65S
Dover, NJ 07801

METCALFE, DR. A.
Solar Turbine International
ATTN: DR. ARTHUR METCALFE
Associate Director, Research
Mail Stop R1, P.O. Box 80966
2200 Pacific Highway
San Diego, CA 92138

MEYER, J. D.
Tech Tran Corporation
ATTN: MR. JOHN D. MEYER
President
1062 Alton Court
Naperville, IL 60540

MEYER, L. D.
General Electric Company
ATTN: MR. LESLIE D. MEYER
Aircraft Engine Group
Mail Stop G-8
Evendale, OH 45215

MICHAEL, J. G.
McDonnell Douglas Astronautics Co.
ATTN: MR. J. G. MICHAEL
Dept. E080, Bldg. 107, Room 316
Post B-2
P.O. Box 516
St. Louis, MO 63166

MICHEL, FREDERICK J.
US Army Matl Dev & Read Cmd
ATTN: MR. FREDERICK J. MICHEL
Acting Chief, Office of MT
DRCMT
5001 Eisenhower Avenue
Alexandria, VA 22333

MICILLO, C.
Grumman Aerospace Corp.
ATTN: MR. CARL MICILLO
Manager
Mail Stop A04-12
So. Oyster Bay Road
Bethpage, NY 11714

MILLER, F.
AF Wright-Aeronautical Lab
ATTN: MR. FRED MILLER
AFWAL/MLTM
Wright-Patterson AFB, OH 45433

MILLER, J.
AVCO-Lycoming
ATTN: MR. JULE MILLER
Chief, Manufacturing Div.
550 S. Main Street, LSA-3
Stratford, CT 06497

MINDLIN, HAROLD
Battelle-Columbus Labs
ATTN: MR. HAROLD MINDLIN
Prog. Mgr., Metals & Ceramics
Information Center
505 King Avenue
Columbus, OH 43201

MITCHELL, S.
General Electric Co., Aircraft Eng. Gr.
ATTN: MR. STEPHEN MITCHELL
Advanced Frames Manager
Mail Stop H36
1 Neumann Way
Evendale, OH 45215

(PARROTT) MONTAGUE, R. J.
Naval Sea Systems Command
ATTN: MS. RAYE J. (PARROTT) MONTAGUE
CODE SEA 03R3
Washington, DC 20362

MONTUORI, V. H.
Watervliet Arsenal-Benet Weapons Lab
ATTN: MR. VICTOR H. MONTUORI
Adv. Eng. Section
Building 40
Watervliet, NY 12189

MOORE, J. B.
Pratt & Whitney
ATTN: MR. JOSEPH B. MOORE
Director, Matls. Eng. & Tech.
Mail Stop B150
P.O. Box 2691
West Palm Beach, FL 33402

MOORE, R. E.
Hughes Helicopters
ATTN: MR. RICHARD E. MOORE
Manager, R&D Dept.
Mail Stop T490
Culver City, CA 90230

MOORE, T. L.
Bendix Energy Controls Division
ATTN: MR. TED L. MOORE
Director of Operations
717 N. Bendix Drive
South Bend, Indiana 46620

MORIARTY, B. J.
Charles Stark Draper Laboratory
ATTN: MR. BRIAN J. MORIARTY
Mail Stop 03
555 Technology Square
Cambridge, MA 02139

MORRISEY, E. J.
AF Wright Aeronautical Laboratory
ATTN: MR. EDWARD J. MORRISEY
AFWAL-MLSE
Wright-Patterson AFB, OH 45433

MOSS, JR., C. W.
Babcock & Wilcox
ATTN: MR. CHARLES W. MOSS, JR.
Marketing Specialist
Mail Stop 44
P.O. Box 785
Lynchburg, VA 24505

MULDOON, T. F.
Numerical Control Society
ATTN: MR. T. F. MULDOON
Tech. Vice President
9912 So. Pioneer Boulevard
Santa Fe Springs, CA 90670

MURPHY, J. J.
Raytheon Company
ATTN: MR. JOHN J. MURPHY
Mail Stop 91
528 Boston Post Road
Sudbury, MA 02154

MUSTICO, COL R. J.
Air Force Logistics Command
ATTN: COL RICHARD J. MUSTICO
Director, Fac & Prod. Eng.
DCS/Maintenance
AFLC/MAX
Wright-Patterson AFB, OH 45433

NADER, E. M.
Program Mgr, XM-1 Tank, TARADCOM
ATTN: MR. EDWARD M. NADER
DRCPM-GCM-F
Warren, MI 48090

NASH, A. G.
US Army Armament R&D Command - LCWSL
ATTN: MR. ALBERT G. NASH
Ch, Tube Fired Fuze Br, Nuc & Fuze Div
Dover, NJ 07801

NEAL, J. K.
Air Logistics Center
ATTN: MR. JOHN K. NEAL
SA-ALC/MMPRT
Kelly AFB, TX 78212

NEAL, R. K.
Vought Corporation
ATTN: MR. RAYMOND NEAL
M/S 2-22030
P.O. Box 225907
Dallas, TX 75265

NEY, G.
US Army Industrial Base Eng. Activity
ATTN: MR. GORDON NEY
DRXIB-MT
Rock Island, IL 61299

NICHOLOFF, A.
HQ, Air Force Logistics Command
ATTN: MR. ANDREW NICHOLOFF
AFLC/MAXT
Wright-Patterson AFB, OH 45433

NIEDERMAN, COL N. E.
Los Angeles Air Force Station
ATTN: COL NORMAN E. NIEDERMAN
Dir. of Mfg. & Quality Assurance
SD/PMD
P.O. Box 92960, Worldway Postal Center
Los Angeles, CA 90009

NOHREN, JR., J. E.
Innova, Inc.
ATTN: MR. JOHN E. NOHREN, JR.
President
5170 126th Street, North
Clearwater, FL 33520

O'BRIEN, B. J.
TRW, Defense & Space Systems
ATTN: MR. BERNARD J. O'BRIEN
Senior Mfg. Staff Engineer
M3/2107
One Space Park
Redondo Beach, CA 90278

OLAH, M. F.
Raytheon Co
ATTN: MR. MICHAEL OLAH
5717 Huberville Avenue-Suite 200
Dayton, OH 45431

ORPHANOS, J. A.
Hanscom Air Force Base
ATTN: MR. JOHN A. ORPHANOS
Director of Manufacturing
ESD/TOM, M/S 36
Hanscom Air Force Base
Bedford, MA 01731

ORRIS, A. A.
Alum Precision Products, Inc.
ATTN: MR. ALBERT ORRIS
2621 South Susan Street
Santa Ana, CA 92704

OYLER, G.
American Welding Society
ATTN: MR. GLENN OYLER
2501 Northwest 7th Street
Miami, FL 33125

PABLO, M. R.
Naval Research Laboratory
ATTN: MR. MANUEL R. PABLO
Code 6009
Washington, DC 20375

PANKEY, JR., LTC JAMES L.
Aeronautical Systems Division
ATTN: LTC JAMES L. PANKEY, JR.
ASD/YWD
Wright-Patterson AFB, OH 45433

PANZARELLA, P. P.
Aeronautical Systems Division
ATTN: MR. PHILLIP P. PANZARELLA
Asst. Deputy Cmdr for Aircraft MOD
4950/AM
Wright-Patterson AFB, OH 45433

PARISH, H. G.
Litton Industries
ATTN: MR. H. G. PARISH
Electron Tube Division
1215 So. 52nd Street
Tempe, AZ 85281

PARK, B. C.
US Army Missile Command
ATTN: MR. BOBBY C. PARK
Adv. Sys. Dev. Mfg.
DRSMI-RST
Redstone Arsenal, AL 35809

PARSONS, J. H.
Naval Air Rework Facility
ATTN: MR. JOHN H. PARSONS
CODE 644
Naval Air Station
Alameda, CA 94501

PATSFALL, R. E.
General Electric Company
ATTN: MR. RALPH E. PATSFALL
Mgr., Mfg. Tech. Operations
Mail Drop A-273
Interstate 75
Cincinnati, OH 45211

PAULINSKI, D. W.
Sperry Univac
ATTN: MR. DENNIS W. PAULINSKI
Manager, Engineering
Mail Stop U2U25
P.O. Box 3525
St. Paul, MN 55165

PEBLY, H. E.
Plastics Tech Evaluation Center (ARRADCOM)
ATTN: MR. HARRY E. PEBLY
DRDAR-SCM-O
Dover, NJ 07801

PENTON, A. P.
McDonnell Douglas Astronautics Corp.
ATTN: MR. ALLEN PENTON
A3-208, 13-3
5301 Bolsa Avenue
Huntington Beach, CA 92647

PENTON, J. W.
US Army Materiel Dev. & Read. Cmd
ATTN: MR. JOSEPH W. PENTON
Public Information Officer
DRCIN-PI
5001 Eisenhower Avenue
Alexandria, VA 22333

PETERSEN, R. S.
Lockheed Missiles & Space Co., Inc.
ATTN: MR. R. S. PETERSEN
Manager
B170/86-30
P.O. Box 504
Sunnyvale, CA 94086

PETRONE, J.
US Army Industrial Base Eng. Activity
ATTN: MR. JOHN PETRONE
DRXIB-MT
Rock Island, IL 61299

PETRUSHA, J.
Garrett Airesearch Corp.
ATTN: MR. JOHN PETRUSHA
Mail Stop 101-1
111 S. 34th Street
Box 5217
Phoenix, AZ 85010

PHELPS, W. M.
McDonnell Douglas Elec. Co.
ATTN: MR. WILLIAM W. PHELPS
Director, Manufacturing
Dept. 1700
2600 N. Third Street
St. Charles, MO 63301

PHILLIPS, R. M.
Litton Industries
ATTN: MR. ROBERT M. PHILLIPS
Manager, Special Projects
Electron Tube Div., Linear Beam Dept.
960 Industrial Road
San Carlos, CA 94070

PHILLIPS, R. H.
Univ of IL at Chicago Circle
ATTN: MR. ROHAN PHILLIPS
Dept of Mat'ls Eng
Box 4348
Chicago, IL 60680

PINCKNEY, R.
Boeing Vertol Company
ATTN: MR. ROBERT PINCKNEY
Advanced Technology, P62-06
P.O. Box 16858
Philadelphia, PA 19142

PIONKE, L. J.
McDonnell Douglas Astronautics
ATTN: MR. LAWRENCE J. PIONKE
Dept. E457, Bldg. 270E/3/PST. E14
Mail Stop 024
P.O. Box 516
St. Louis, MO 63166

PLEW, L. E.
Naval Weapon Support System
ATTN: MR. LARRY E. PLEW
CODE 3073
Building 2906
Crane, IN 47522

PLOUDRE, M.
US Army Aviation R&D Command
ATTN: MR. MILTON PLOUDRE
DRDAV-EGX
4300 Goodfellow Boulevard
St. Louis, MO 63120

POLANSKY, D.
National Bureau of Standards
ATTN: MR. DANIEL POLANSKY
RAD-P, C-216
Washington, DC 20234

POPE, G. E.
Harry Diamond Laboratories
ATTN: MR. GLEN E. POPE
DELHD-PO-P
2800 Powder Mill Road
Adelphi, MD 20783

PRESTON, CAPT R. R.
AF Wright Aeronautical Laboratories
ATTN: CAPT RICHARD R. PRESTON
AWAL/MLTC
Wright-Patterson AFB, OH 45433

PRINCE, D.
Commander, Hanscom Air Force Base
ATTN: MR. DAN PRINCE
ESD/TOM
Mail Stop 36
Hanscom AFB, MA 01731

QUIGLEY, F. C.
US Army Matls & Mech Research Center
ATTN: MR. FRANCIS C. QUIGLEY
Chief, Process Development Division
Metals & Ceramics Laboratory
DRXMR-ER
Watertown, MA 02172

RAGANO (RET), MG F. P.
American Defense Preparedness Assoc.
ATTN: MG F. P. RAGANO (RET)
Suite 900
1700 N. Moore
Arlington, VA 22090

RANDLE, D. R.
Naval Weapons Center
ATTN: MR. DALE R. RANDLE
Code 364
China Lake, CA 93555

RAZZETTI, L.
Westinghouse - DESC
ATTN: MR. LOUIS RAZZETTI
Mail Stop V-14
P.O. Box 746
Baltimore, MD 21203

REAVES, P.
Naval Ocean Systems Center
ATTN: MR. PAT REAVES
CODE 9204
271 Catalina Blvd.
San Diego, CA 92152

REED, DR. D. L.
General Dynamics
ATTN: DR. DANNY L. REED
Manager, Mfg. Tech.
Mail Stop 6219
P.O. Box 748
Fort Worth, TX 76101

REED, D.
Texas Instruments
ATTN: MR. DON REED
Operations Manager, Equipment Group
M/S 2231, N Building
P.O. Box 226015
Dallas, TX 75266

REEVE, JR., R. C.
Advanced Robotics Corp.
ATTN: MR. RONALD C. REEVE, JR.
President
Newark Ohio Industrial Park
Building 8, Route 79
Hebron, OH 43025

REID, M. D.
Doehler-Jarvis Castings
ATTN: MR. MARVIN D. REID
P.O. Box 8041
Kentwood, MI 49508

REINECKE, A. J.
US Army Logistics Mgmt. Ctr.
ATTN: MR. A. J. REINECKE
DRXMC-ITC-E
DARCOM Intern Training Center
Red River Army Depot
Texarkana, TX 75007

REMSKI, R.
Honeywell, Avionics Div.
ATTN: MR. ROBERT REMSKI
Prin. Production Engr.
M/S MN15-2390
1625 Zarthan Avenue
St. Louis Park, MN 55416

RENTON, W. J.
Vought Corporation
ATTN: MR. W. JAMES RENTON
Manager, Advanced Composites
P.O. Box 225907
Dallas, TX 75265

REUTTER, J. R.
A. T. Kearney, Inc.
ATTN: MR. JOHN R. REUTTER
Manager
222 South Riverside Plaza
Chicago, IL 60606

REUWER, M.
Chemical Systems Laboratory, ARRADCOM
ATTN: MR. M. REUWER
Associate for Engineering
DRDAR-CLG
Aberdeen Proving Ground, MD 21010

RICHTER, H. E.
IBM Corporation
ATTN: MR. HARRY E. RICHTER
Ind. Consultant
1133 Westchester Avenue
White Plains, NY 10604

RIESGRAF, M.
Honeywell Inc., Avionics Division
ATTN: MR. MATT RIESGRAF
MN17-1521
2600 Ridgeway Parkway
Minneapolis, MN 55413

RIGDON, C.
Naval Electronic Systems Cmd
ATTN: MR. CARL RIGDON
ELEX 504512
Washington, DC 20360

RIGGS, E. W.
Naval Weapons Support Center
ATTN: MR. EARL W. RIGGS
Code 3073
Building 2917
Crane, IN 47522

RIPKEN, J. H.
McDonnell Douglas Astronautics Co.
ATTN: MR. JAMES H. RIPKEN
Senior Manufacturing Engineer
M/S 12-2
5301 Bolsa Avenue
Huntington Beach, CA 92647

RIZZO, F.
Crucible Research Center
ATTN: MR. FRANK RIZZO
Engineering Supervisor
Pittsburgh, PA 15230

ROBERTSON, A. R.
General Dynamics, Convair Div.
ATTN: MR. A. R. ROBERTSON
Manager, Manufacturing Technology
Mail Stop 52-4000
P.O. Box 80847
San Diego, CA 92138

ROGERS, G. P.
Pratt & Whitney Aircraft Group
ATTN: MR. GEORGE P. ROGERS
Government Business Rep.
M/S OBA-2N
400 Main Street
East Hartford, CT 06108

ROGERS, M. H.
Office of Secretary of Air Force
ATTN: MR. MARTIN H. ROGERS
SAF/ALP
The Pentagon
Washington, DC 20330

ROLSTON, P. W.
US Army Mat. & Mech. Res. Ctr.
ATTN: MR. PAUL W. ROLSTON
DRXMR-MQ
Watertown, MA 02172

RUBENSTEIN, A.
General Electric Company
ATTN: MR. AL RUBENSTEIN
Mfg. Eng. Consulting & Appl. Ctr
Building 36, Room 631
1 River Road
Schenectady, NY 12345

RUBENSTEIN, R. S.
General Electric Co., Aircraft Engine Gr.
ATTN: MR. RALPH S. RUBENSTEIN
Manager, Business Plans and Practices
Mail Stop 174AD
1000 Western Avenue
Lynn, MA 01910

RUSNAK, J. P.
Pratt & Whitney Aircrafg Group, UTC
ATTN: MR. JAMES P. RUSNAK
Technology & Research Mgr., Marketing
Mail Stop PBGF, R-15
P.O. Box 2691
West Palm Beach, FL 33402

RUWE, DR. V. W.
US Army Missile Command
ATTN: DR. VICTOR W. RUWE
DRSMI-RST
Redstone Arsenal, AL 35809

RYAN, R.
A. T. Kearney, Inc.
ATTN: MR. RAY RYAN
Manager
699 Prince Street
P.O. Box 1405
Alexandria, VA 22313

SADLER, R. L.
Bendix Corporation
ATTN: MR. ROBERT L. SADLER
P.O. Box 1159
Kansas City, MO 64141

SAFFIAN, L.
US Army Armament R&D Command, LCWSL
ATTN: MR. L. SAFFIAN
Chief, Energetic Sys. Proc. Div.
DRDAR-LCM
Building 3342
Dover, New Jersey 07801

SAFIER, B. S.
Director, Naval Matl Cmd Ind Res Det
ATTN: MR. BILL S. SAFIER
Code 04X
Building 75-2
Naval Base
Philadelphia, PA 19112

SAKAI, J. M.
Naval Air Rework Facility
ATTN: MR. JEFF M. SAKAI
CODE 340
Building 341
North Island
San Diego, CA 92135

SALLOT, B. M.
Society of Manufacturing Engineers
ATTN: MR. BERNARD M. SALLOT
Dir., Professional and Gov. Activities
One SME Drive
P.O. Box 930
Dearborn, MI 48128

SAMPSON, R. W.
Central Intelligence Agency
ATTN: MR. ROGER W. SAMPSON
P.O. Box 1925
Washington, DC 20013

SANII, E.
University of Miami
ATTN: MR. EZAT SANII
Assistant Professor
Industrial Engineering Dept.
Coral Gables, FL 33124

SAXMAN, J. A.
Naval Avionics Center
ATTN: MR. JAMES A. SAXMAN
Director, CAM & Test Technology Div.
Mail Stop D/240
6000 E. 21st Street
Indianapolis, IN 46219

SCHMIDT, R. N.
Honeywell, Inc.
ATTN: MR. ROGER N. SCHMIDT
Assistant to Director
MN19-T460
1700 West Highway 36
Roseville, MN 55113

SCHRADER, G. E.
TRW, Inc.
ATTN: MR. GUSTAV E. SCHRADER
Vice Pres., Mfg. & Tech. Services
T/M 2424
23555 Euclid Avenue
Cleveland, OH 44117

SCHUCK, G.
US Army Materiel Dev. & Read. Cmd.
ATTN: MR. GEORGE SCHUCK
ATTN: DRCMT
5001 Eisenhower Avenue
Alexandria, VA 22333

SCHULTZ, J. D.
Naval Air Systems Command
ATTN: MR. JOHN D. SCHULTZ
CODE AIR 5162C5
Washington, DC 20361

SCOTT, C.
Vought Corporation
ATTN: MR. CAL SCOTT
Sr. Ind. Engr.
9316 Jefferson
Dallas, TX

SCOTT, JR., N.
US Army Armament R&D Command
ATTN: MR. NATHANIEL SCOTT, JR.
DRDAR-SCF-FM
Building 65 South
Dover, New Jersey 07801

SEITZ, DAVID W.
US Army Matls & Mech Res Ctr
ATTN: MR. DAVID W. SEITZ
DRXMR-PMT
Technology Plan. & Mgmt. Div.
Watertown, MA 02172

SELBY, W. E.
Boeing Aerospace Co.
ATTN: MR. WILLIAM E. SELBY
Director, Mfg.
M/S 1F57
P.O. Box 3999
Seattle, WA 98124

SGARRO, R. R.
Aeronautical Systems Div.
ATTN: MR. R. R. SGARRO
Director of Manufacturing/QA
ASD/PMD
Wright-Patterson AFB, OH 45433

SHARPLESS, G. C.
Albany International Research Company
ATTN: MR. GARRETT C. SHARPLESS
Senior Research Assoc.
Route 129 at U.S. 1
Dedham, MA 02026

SHAUGHNESSY, F. O.
PRC Ridgecrest Engineering Company
ATTN: MR. FREDERICK O. SHAUGHNESSY
Manager, Data/Configuration Dept.
1415-B N. Norma Street
Ridgecrest, CA 93555

SHAW, R. B.
Air Force Systems Command
ATTN: MR. ROBERT B. SHAW
Aeronautical Systems Division
ATTN: YYD
Wright-Patterson AFB, OH 45433

SHEETS, D.
Air Force Acquisition Log. Div.
ATTN: MR. DAN SHEETS
AFALD/PTEEL
Wright-Patterson AFB, OH 45433

SHEPHARD, L.
General Electric Company
ATTN: MR. LARRY SHEPHARD
Building K1, Room 5C19
P.O. Box 8
Schnectady, NY 12345

SHOW, W. A.
Eglin Air Force Base
ATTN: MR. WILLIAM A. SHOW
AD/PMD
Eglin Air Force Base, FL 32542

SIEGEL, M.
Pratt & Whitney Aircraft
ATTN: MR. MEL SIEGEL
Manager, Materials
721 Robin Way
N. Palm Beach, FL 33408

SIGAL, E. B.
Naval Ship Systems Eng. Station
ATTN: MR. EDWARD B. SIGAL
Code 035
Philadelphia Naval Base
Philadelphia, PA 19112

SIKLOSI, A. E.
Mun. Prod. Base Mod. Agency
ATTN: MR. ALBERT E. SIKLOSI
SARPMM-PBM-E
M/S 171
Dover, New Jersey 07801

SILVESTRI, G.
Naval Underwater Sys Center
ATTN: MR. GIOVANNI SILVESTRI
CODE 36012
Building 679
Newport Lab
Newport, RI 02840

SINGER, H. B.
Charles Stark Draper Labs
ATTN: MR. HERBERT B. SINGER
Mail Stop 42
555 Technology Square
Cambridge, MA 02139

SKERRETT, P. E.
AVCO Everett Research Laboratory
ATTN: MR. PETER E. SKERRETT
Marketing Manager
2385 Revere Beach Parkway
Everett, MA 02149

SKRYPA, DR. M. J.
Allied Chemical Corporation
ATTN: DR. M. J. SKRYPA
Production Manager
P.O. Box 1021R
Morristown, NJ 07960

SMITH, B.
Bureau of Standards
ATTN: MR. BRAD SMITH
A123, Bldg. 220
Washington, DC 20234

SMITH, G.
Defense Ind. Plant Equip. Ctr.
ATTN: MR. GARLAND SMITH
TFM
Airways Boulevard
Memphis, TN 38114

SMITH, P. J.
Naval Weapons Support Center
ATTN: MR. PHILIP J. SMITH
Code 505
Crane, IN 47522

SMITH, R. L.
McDonnell Douglas Electronics Company
ATTN: MR. ROBERT L. SMITH
Manager, Quality Engineering
Dept. 1600
P.O. Box 426
St. Charles, MO 63301

SPALSBURY, W. A.
Battelle Columbus Labs
ATTN: MR. WILLIAM A. SPALSBURY
Metals & Ceramics Info. Center
M/S ME1E
505 King Avenue
Columbus, OH 43201

SPORTELLI, L. G.
IBM Corporation
ATTN: MR. LOUIS G. SPORTELLI
Division Director of Manufacturing
Federal Systems Div., RM 2C18
10215 Fernwood Road
Bethesda, MD 20034

STANDER, M.
Naval Air Systems Command
ATTN: MR. MAXWELL STANDER
AIR 5163D3
Washington, DC 20361

STEELE, B.
Systems Research Laboratory, Inc.
ATTN: MR. BENNIE STEELE
Mail Stop IR50
2800 Indian Ripple Road
Dayton, OH 45440

STELLABOTTE, M. L.
Naval Air Development Center
ATTN: MR. MICHAEL L. STELLABOTTE
Code 606C
Warminster, PA 18974

STETTER, C. G.
Stetter Associates, Inc.
ATTN: MR. CHARLES G. STETTER
935 E. Meadow Drive
Palo Alto, CA 94303

STONER, R. W.
Vought Corporation
ATTN: MR. ROBERT W. STONER
Vice Pres. of Operations Dev.
Mail Stop 2-20,000
P.O. ox 225907
Dallas, TX 75265

STOYKO, M. A.
US Army Mun. Prod. Base Mod. Agency
ATTN: MR. MICHAEL A. STOYKO
SARPM-PBM-J
Dover, NJ 07801

STRASSNER, R.
Doehler Jarvis Castings (NL Industries)
ATTN: MR. RAY STRASSNER
1945 Smead Avenue
Toledo, OH 43601

STURGES, R. H.
Westinghouse Electric Corp.
ATTN: MR. R. H. STURGES
Mail Stop 601-1B27
1310 Beulah Road
Pittsburgh, PA 15235

SULLIVAN, J. H.
US Army Industrial Base Eng. Activity
ATTN: MR. JAMES H. SULLIVAN
DRXIB-MT
Rock Island, IL 61299

SULLIVAN, W.
General Electric Co., Aircraft Engine Gr.
ATTN: MR. WILLIAM SULLIVAN
Manager, Manufacturing Engineering
Mail Stop 17003
1000 Western Avenue
Lynn, MA 01910

SUMMERBELL, W. E.
W. E. Summerbell Company
ATTN: MR. WILLIAM E. SUMMERBELL
President
P.O. Box 2564
Arlington, VA 22201

SUTTON, G. P.
Lawrence Livermore Lab
ATTN: MR. GEORGE P. SUTTON
Deputy Program Leader
M/S L-506
P.O. Box 808
Livermore, CA 94550

SWART, W. T
General Dynamics
ATTN: MR. W. T. SWART
Department 497
Mail Stop 5306B
P.O. Box 85039
San Diego, CA 92138

SYED, A.
Naval Air Rework Facility
ATTN: MR. ASGHAR SYED
Code 640
Naval Air Station
Norfolk, VA 23511

TANNER, J. P.
American Institute of Industrial Engineer
ATTN: MR. JOHN P. TANNER
1410 Pinar Drive
Orlando, FL 32817

TASCH, R. P.
Philadelphia Naval Shipyard
ATTN: MR. ROBERT P. TASCH
CODE 385.1
Philadelphia, PA 19112

TAWANCY, H.
Cabot Carr
ATTN: MR. HANI TAWANCY
Eng. Associate
1020 W. Park Avenue
Kokoma, IN 46901

TAYLOR, A. T.
Boeing Commercial Airplane Company
ATTN: MR. ALLAN T. TAYLOR
Manager, Mfg. Research and Development
Mail Stop 9R-35
P.O. Box 3707
Seattle, WA 98124

TESAR, D.
University of Florida
ATTN: PROF. DELBERT TESAR
Ctr of Intelligent Machines & Robotics
Mechanical Engineering
Gainesville, FL 32611

THELLMANN, E. L.
Gould, Inc.
ATTN: MR. EDWARD L. THELLMANN
Gould Laboratories
Department 741
18901 Euclid Avenue
Cleveland, OH 44117

THOMPSON, A.
General Electric Co., Aircraft Engine Gr.
ATTN: MR. ARTHUR THOMPSON
Manager, Quality Measurement Systems
Mail Stop E45
175 and Newman Way
Cincinnati, OH 45215

THOMPSON, JR., DR. JOHN R.
Naval Surface Weapons Center
ATTN: DR. JOHN R. THOMPSON, JR.
Code G-52
Building 203
Dahlgren, VA 22448

TOBIAS, I.
TRW, Inc.
ATTN: MR. IVAN TOBIAS
M3/2282
1 Space Park
Redondo Beach, CA 90278

TOMASHOT, R. C.
AF Wright Aeronautical Lab
ATTN: MR. R. C. TOMASHOT
AFWAL/ML
Wright-Patterson AFB, OH 45433

TOTH, I.
TRW, Inc.
ATTN: MR. ISTVAN TOTH
Manager, Materials Dev.
Mail Stop 3293
23555 Euclid Avenue
Cleveland, OH 44117

TOTON, E. J.
General Motors Technical Center
ATTN: MR. EDWARD J. TOTON
Sr. Staff Engineer
Mfg. Dev. EA Bldg.
30000 Mound Road
Warren, MI 48090

TROY, J. W.
Naval Ocean Systems Center
ATTN: MR. JUNN W. TROY
CODE 9203
271 Catalina Blvd.
San Diego, CA 92152

TULKOFF, J.
Lockheed-Georgia Company
ATTN: MR. JOSEPH TULKOFF
Director of Manufacturing Technology
86 South Cobb Drive
Marietta, GA 30066

TUTKA, J. L.
US Army Aviation R&D Command
ATTN: MR. JAMES L. TUTKA
4300 Goodfellow Boulevard
St. Louis, MO 63120

TWEEDDALE, DR. J. W.
Office of Asst. Sec. of the Navy
ATTN: DR. JAMES W. TWEEDDALE
Director, Productivity Management
Washington, DC 20360

ULEAREY, E. C.
Philadelphia Naval Shipyard
ATTN: MR. ELMER C. ULEAREY
Code 101
Philadelphia, PA 19112

ULRICH, T. H.
Westinghouse Corp.
ATTN: MR. THOMAS H. ULRICH
Mail Stop 271
P.O. Box 746
Baltimore, MD 21203

URQUHART, G. K.
Boeing Aerospace Company
ATTN: MR. GORDON K. URQUHART
Operations Manager
Mail Stop 84-54
P.O. Box 3999
Seattle, WA 98124

VALENTINE, G. W.
Hughes Aircraft Company
ATTN: MR. GARY W. VALENTINE
Mail Stop 6/C136
Centinela & Teale Streets
Culver City, CA 90230

VALORI, R.
Naval Air Propulsion Center
ATTN: MR. RAYMOND VALORI
PF72
P.O. Box 7176
Trenton, NJ 08628

VAN NIEROP, J.
E-Systems, Inc., ECI Division
ATTN: MR. JOHN VAN NIEROP
Manager, Test Engineering
Mail Stop 13
1501 72nd Street, N.
St. Petersburg, FL 33710

VanWINKLE, D. B.
Air Force Systems Command
ATTN: MR. DAVID B. VanWINKLE
Foeign Technology Division
Wright-Patterson AFB, OH 45433

VAUGHAN, R. W.
TRW, Inc.
ATTN: MR. ROBERT W. VAUGHAN
Manager
Mail Stop 01-2171
One Space Park
Redondo Beach, CA 90266

VINCENT, D. A.
Society of Manufacturing Eng.
ATTN: MR. DONALD A. VINCENT
Manager, Associate Services
One SME Drive
P.O. Box 930
Dearborn, MI 48128

VOJNOVICH, T.
Westinghouse Electric Corporation
ATTN: MR. TED VOJNOVICH
R&D Center
Beulah Road
Pittsburgh, PA 15235

VOLLMER, R. G.
US Army Aviation R&D Command
ATTN: MR. ROBERT G. VOLLMER
ATTN: DRDAV-EGX
4300 Goodfellow Boulevard
St. Louis, MO 63120

VOLTAGGIO, JR., F.
Northrop Corporation
ATTN: MR. FRANK VOLTAGGIO, JR.
600 Hicks Road
Rolling Meadows, IL 60008

VOSS, LTC J. D.
Air Force Systems Command
ATTN: LTC JOHN D. VOSS
Dep. Dir., R&D Contracting
ASD/PMR
Wright-Patterson AFB, OH 45433

WAKEFIELD, S. L.
General Electric Company
ATTN: MS. SHIRLEY L. WAKEFIELD
Mktg Programs, Quality & Mfg. Processes
M/S H-9, Aircraft Engine Gr.
1 Neumann Way - I75
Cincinnati, OH 45215

WALDMAN, DR. J.
US Army Armament R&D Command
ATTN: DR. JEFFREY WALDMAN
DRDAR-SCM-P
Building 355
Dover, New Jersey 07801

WALLACE, R.
Pratt & Whitney Aircraft
ATTN: MR. RAYMOND WALLACE
Marketing Engineer
118 West First Street
Dayton, OH 45402

WALLENTINE, R. E.
Weber State College
ATTN: MR. ROBERT E. WALLENTINE
Mfg Engineering Tech
3750 Harrison Blvd, 1802
Ogden, UT 84408

WALTERS, J. J.
AVCO Lycoming Division
ATTN: MR. JEREMY J. WALTERS
Director
550 So. Main Street
Stratford, CT 06497

WALTERS, W. C.
Rockwell International
ATTN: MR. W. C. WALTERS
Dir., Adv. Mfg., Elec. Oper.
Mail Stop 407-.00
P.O. Box 1046
Dallas, TX 7520

WALTON, L. F.
Naval Matl Cmd Ind Res Det
ATTN: MR. LOUIS F. WALTON
Code 04X27
Building 75-2
Naval Base
Philadelphia, PA 19112

WAMSLEY, J. R.
US Army Foreing Science & Tech Ctr
ATTN: MR. JAMES R. WAMSLEY
220 7th Street, NE
MS MTI
Charlottesville, VA 22901

WARD, J. P.
Rohr Industries
ATTN: MR. JOHN P. WARD
P.O. Box 878
Chula Vista, CA

WATSON, W. H.
Naval Ocean Systems Center
ATTN: MR. WILBUR H. WATSON
Code 714
271 Catalina Avenue
San Diego, CA 92152

WEINFURTNER, G. W.
American Welding Society
ATTN: MR. GEORGE W. WEINFURTNER
Executive Director
2501 N.W. 7th Street
Miami, FL 33125

WEITNER, W.
Aerospace Industries Assoc.
ATTN: MR. WALTER WEITNER
Director, Aerospace Opns. Serv.
Suite 700
1725 DeSales Street, NW
Washington, DC 20036

WELLS, JR., R. N.
Naval Sea Systems Command
ATTN: MR. ROY N. WELLS, JR.
NC #3, Room 6E06
Washington, DC 20362

WELSH, W. J.
Naval Matl Cmd Ind Res Det
ATTN: MR. WILLIAM J. WELSH
Code 04X24
Building 75-2
Naval Base
Philadelphia, PA 19112

WENZEL, LTC T. E.
Aeronautical Systems Division
ATTN: LTC THOMAS E. WENZEL
ASD/AXT
Wright-Patterson AFB, OH 45433

WHITE, J. W.
Aerojet Tactical Systems
ATTN: MR. JAMES W. WHITE
Director, Manufacturing
Building 2019
P.O. Box 13400
Sacramento, CA 95813

WHITE, M.
Kaman Aerospace Corporation
ATTN: MR. MARK WHITE
Chief, M&P Applications
Old Windsor Road
Bloomfield, CT 06002

WHITEMAN, A. E.
Department of Energy
ATTN: MR. A. E. WHITEMAN
Albuquerque Operations Office
Weapons Development Division
Kirtland AFB, P.O. Box 5400
Albuquerque, NM 87115

WILEY, C.
General Electric Company
ATTN: MR. CHARLES WILEY
Mgr., Dev. Mfg.
3198 Chestnut Street
Philadelphia, PA 19101

WILGER, J. D.
Raytheon Company
ATTN: MR. JAMES D. WILGER
Corporate Representative
5717 Huberville Avenue
Dayton, OH 45431

WILLIAMS, C. G.
E-Systems, Inc., ECI Division
ATTN: MR. C. GERARD WILLIAMS
Director of Manufacturing Eng.
Mail Stop 13
1501 72nd Street, N.
St. Petersburg, FL 33710

WILLIAMS, D.
DLA-DIPEC
ATTN: MR. DON WILLIAMS
Airways Boulevard
Memphis, TN 38114

WILLIAMS, J. L.
Cincinnati Milacron, Inc.
ATTN: JOSEPHINE L. WILLIAMS
Director, Applied Sciences R&D
4701 Marburg Avenue
Cincinnati, oH 45209

WILLS, R. H.
Naval Ocean Systems Center
ATTN: MR. ROBERT H. WILLS
Code 9203
271 Catalina Blvd.
San Diego, CA 92152

WILLYARD, D.
Bendix Corporation
ATTN: MR. DON WILLYARD
P.O. Box 1159
Kansas City, MO 64141

WILSKER, O.
Naval Matl Cmd Ind Res Det
ATTN: MR. OSCAR WILSKER
Code 04X26
Building 75-2
Naval Base
Philadelphia, PA 19112

WILSON, J. W.
Cincinnati Milacron, Inc.
ATTN: MR. JOHN W. WILSON
Sr. Research Associate
Dept. 41D
4701 Marburg Avenue
Cincinnati, OH 45209

WOLFE, W.
Grumman Aerospace Corporation
ATTN: MR. WILLIAM WOLFE
Chief, Eng. Machine Tools
MS B0830
Bethpage, NY 11714

YACKOWSKY, M. F.
USAF - Aeronautical Systems Division
ATTN: MR. MICHAEL F. YACKOWSKY
Program Manager - Planning
ASD/XRS
Wright-Patterson AFB, OH 45433

YEZEK, R.
Grumman Aerospace Corporation
ATTN: MR. ROBERT YEZEK
Asst. Dir., Energy Conservation
Mail Stop 30-30
Bethpage, NY 11714

YOUNT, R.
General Electric Company
ATTN: MR. REED YOUNT
Manufacturing Technology Lab
MD A273
Interstate 75
Cincinnati, OH 45215

ZAJAC, E. A.
General Electric Company
ATTN: MR. EDWIN A. ZAJAC
Mgr, Qual Control-OEP, Ordnance Div
M/S 214
100 Plastics Avenue
Pittsfield, MA 01201

ZAKRAYSEK, L.
General Electric Company
ATTN: MR. LOUIS ZAKRAYSEK
Electronics Park, Bldg. 3, Room 24
Mail Stop A3
Syracuse, NY 13221

ZANIS, C. A.
David Taylor Naval Ship R&D Center
ATTN: MR. CHARLES A. ZANIS
CODE 2820
Fabrication Technology Division
Annapolis, MD 21402

ZONIO, E.
IBM
ATTN: MR. EDMUND ZONIO
Mfg. Eng.
Oswego, NY

ZUTKOFF, A.
Naval Research Laboratory
ATTN: MR. AARON ZUTKOFF
Code 6805
Washington, DC 20375

ZWART, R.
Douglas Aircraft
ATTN: MR. ROBERT ZWART
Manager of Mfg. Res. & Dev.
Mail Stop 1-22, Dept. C-1353
3855 Lakewood Boulevard
Long Beach, CA 90846

ZYBLIKEWYCZ, E.
Naval Matl Cmd Ind Res Det
ATTN: MR. EUGENE ZYBLIKEWYCZ
Code 04X29
Building 75-2
Naval Base
Philadelphia, PA 19112

☆U.S. GOVERNMENT PRINTING OFFICE : 1981—701-796/136